Physics · Introduction to Modern Physics · Modern Electronics

Transistors, Digital and Analog Electronics

thanawiya-archive.com

110	3	51
questions	sets	pages

Contents

Multiple choice questions (47 questions) — Questions · p. 2 — Answers · p. 38

Essay questions (29 questions) — Questions · p. 16 — Answers · p. 44

Past exam questions (34 questions) — Questions · p. 24 — Answers · p. 48

Click a question number to jump to its answer, and an answer number to go back to the question.

thanawiya-archive.com

Multiple choice questions — 47 questions

1 The base region in a transistor is .....

(A) thick, with a high impurity concentration

(B) thin, with a high impurity concentration

(C) thick, with a low impurity concentration

(D) thin, with a low impurity concentration

---

2 In a pnp transistor, the majority charge carriers in both the emitter and the collector are .....

(A) acceptor ions (B) donor ions (C) free electrons (D) holes

---

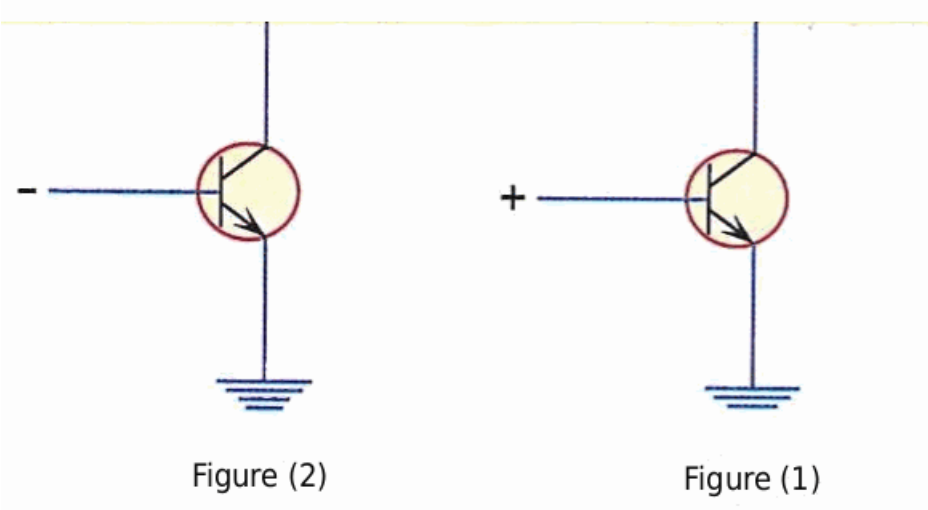
3 An npn transistor is made of .....

(A) one diode junction (B) two diode junctions

(C) three diode junctions (D) four diode junctions

---

4 The two opposite figures (1) and (2) show a transistor connected in a common emitter circuit. In which of them is it used as a switch in the (off) state?



(A) Figure (1) (B) Figure (2) (C) Both figures (D) Neither of them

---

5 In a transistor, the ratio of the impurity concentration in the emitter to that in the collector is .....

(A) equal to one
(B) greater than one
(C) less than one
(D) cannot be determined

6 When a transistor is connected in common base, if the distribution ratio is α_e and the amplification ratio is β_e, then .....

(A) $\alpha_e < 1$
(B) $\beta_e > 1$
(C) $\alpha_e = (\beta_e)/(1 + \beta_e)$
(D) all of the above

7 In a common emitter npn transistor circuit, if the base is given a large positive voltage, the transistor works .....

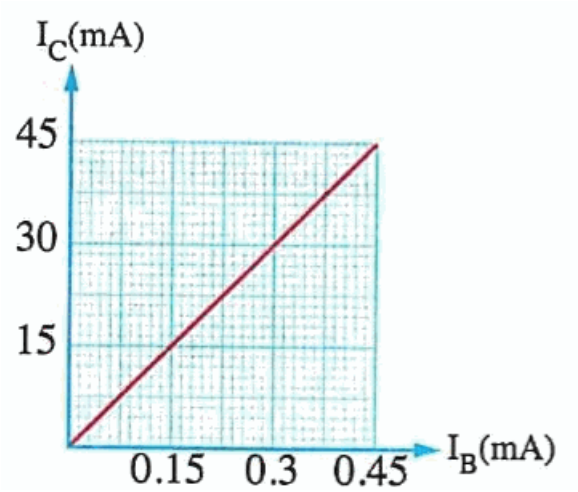
(A) as a half-wave rectifier
(B) as a closed switch
(C) as an open switch
(D) as a full-wave rectifier

8 In an npn transistor, if the collector current is 18 mA and it is 90% of the emitter current, the emitter current (I_E) and the base current (I_B) respectively are .....

(A) 20 mA, 2 mA
(B) 30 mA, 12 mA
(C) 19 mA, 1 mA
(D) 20 mA, 4 mA

9 The opposite graph shows the relation between the collector current (I_C) and the base current (I_B) of a pnp transistor:

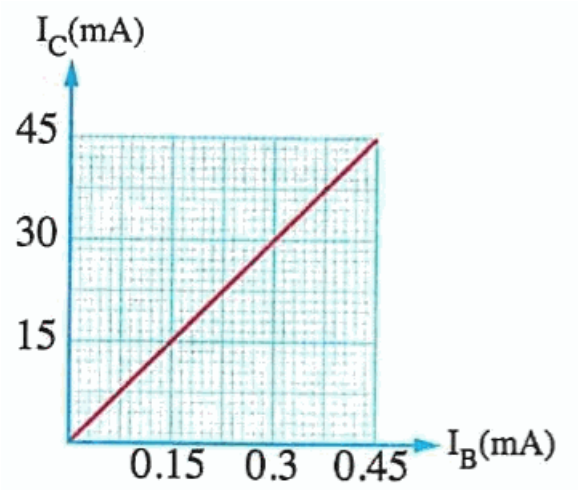
(1) The value of α_e is .....



(A) 0.96
(B) 0.98
(C) 0.99
(D) 1

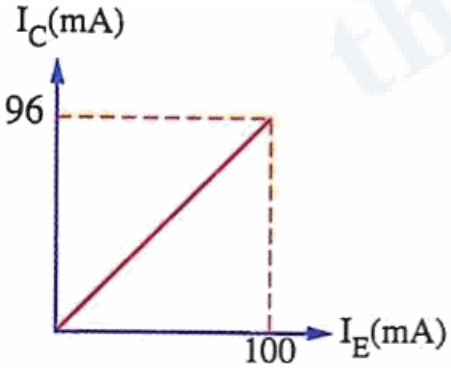
10 The opposite graph shows the relation between the collector current (I_C) and the base current (I_B) of a pnp transistor:

(2) The emitter current when I_C = 45 mA is .....



(A) 20.12 mA (B) 30.15 mA (C) 40.25 mA (D) 45.45 mA

11 The opposite graph shows the relation between the collector current (I_C) and the emitter current (I_E) of an npn transistor. The values of α_e and β_e respectively are .....



(A) α_e: 0.96, β_e: 24 (B) α_e: 0.96, β_e: 48 (C) α_e: 0.49, β_e: 32 (D) α_e: 0.49, β_e: 64

12 If α_e of a transistor is 0.99 and the base current is 100 μA, the amplification factor (β_e) and the collector current (I_C) respectively are .....

(A) β_e: 98, I_C: 9.8×10^{-3} A (B) β_e: 99, I_C: 9.9×10^{-3} A

(C) β_e: 99, I_C: 9.9 A (D) β_e: 98, I_C: 9.8 A

13 If the base current of a transistor is 24 μA and its amplification factor is 24, the distribution constant (α_e) and the collector current (I_C) respectively are .....

(A) α_e: 0.76, I_C: 576×10^{-3} A
(B) α_e: 0.76, I_C: 576×10^{-6} A
(C) α_e: 0.96, I_C: 576×10^{-3} A
(D) α_e: 0.96, I_C: 576×10^{-6} A

14 When the transistor is used as an amplifier, if the electric signal going to its base is 200 μA and the collector current is 10 mA, then β_e and α_e respectively are .....

(A) β_e: 20, α_e: 0.95 (B) β_e: 20, α_e: 0.98 (C) β_e: 50, α_e: 0.95 (D) β_e: 50, α_e: 0.98

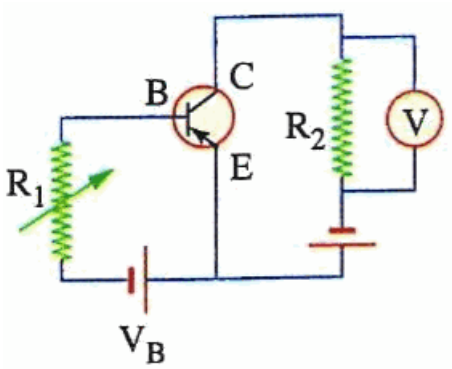
15 If the amplification ratio of an npn transistor is 99 and the collector current is 10 mA, the distribution ratio (α_e) and the emitter current (I_E) respectively are .....

(A) α_e: 0.98, I_E: 10.1×10^{-3} A
(B) α_e: 0.98, I_E: 0.1×10^{-3} A
(C) α_e: 0.99, I_E: 0.1×10^{-3} A
(D) α_e: 0.99, I_E: 10.1×10^{-3} A

16 In a transistor circuit, $(V_{CC} = 1.5\ V)$, the potential difference between the collector and the emitter is $(V_{CE} = 0.5\ V)$ and the collector circuit resistance is $(R_C = 500\ \Omega)$. The collector current (I_C) is .....

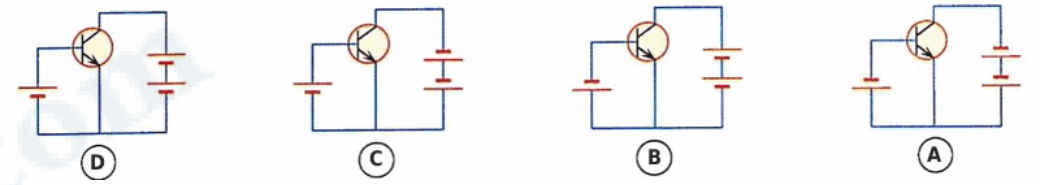
(A) 1×10^{-3} A (B) 2×10^{-3} A (C) 3×10^{-3} A (D) 4×10^{-3} A

17 In the opposite transistor circuit, when the resistance R_1 is increased, the voltmeter reading .....

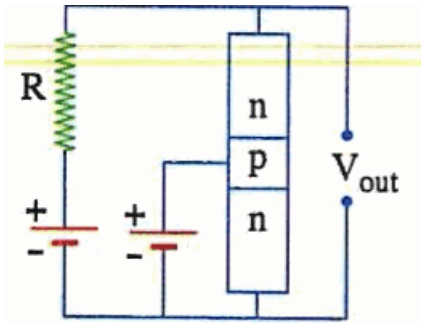


(A) increases
(B) decreases but does not reach zero
(C) stays constant
(D) equals zero

18 The circuit that shows the correct way of connecting the batteries in a common emitter transistor circuit used as a closed switch is .....

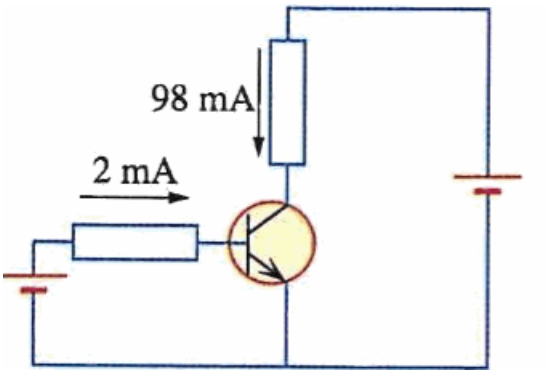


19 In the transistor circuit shown in the figure, the transistor is connected .....



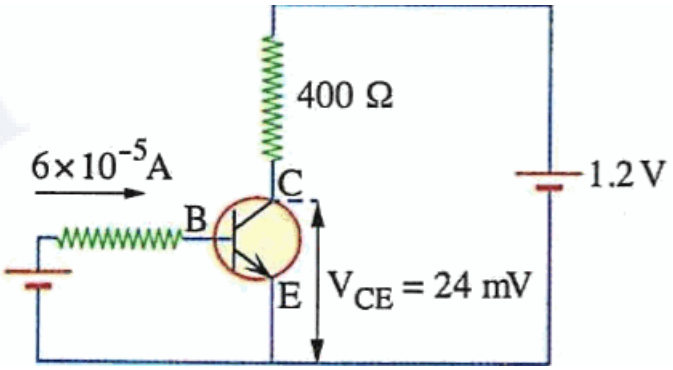
(A) as an open switch
(B) in common emitter
(C) in common base
(D) cannot be determined

20 The figure shows an npn transistor circuit. From the given data, the values of the two constants β_e and α_e respectively are .....



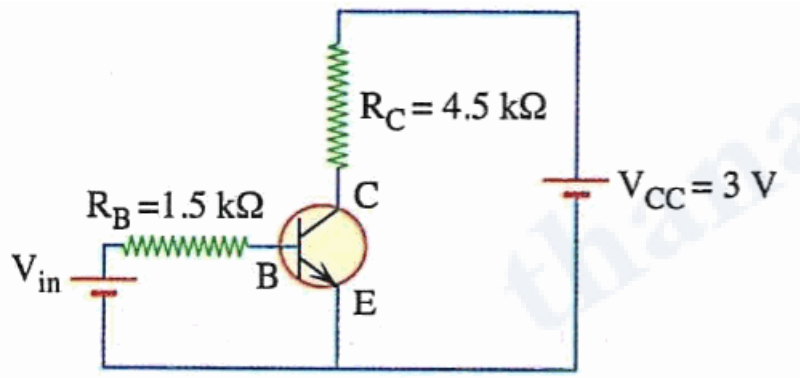
(A) β_e: 50, α_e: 0.98
(B) β_e: 49, α_e: 0.99
(C) β_e: 49, α_e: 0.98
(D) β_e: 50, α_e: 0.99

21 The opposite figure shows an npn transistor circuit. The distribution ratio (α_e) equals .....



(A) 0.92 (B) 0.95 (C) 0.96 (D) 0.98

22 The opposite figure shows a circuit using the transistor as a switch. If the potential difference across the base resistor R_B is 0.01 V and $\beta_e = 75$, then .....



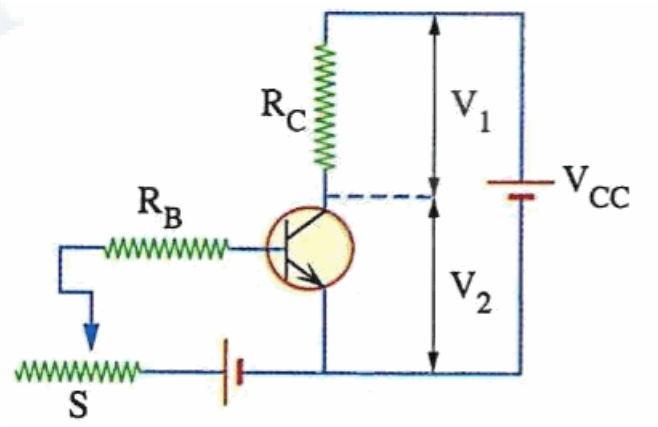
(A) base current (I_B): 3.33×10^{-6} A, output voltage (V_{CE}): 0.55 V

(B) base current (I_B): 3.33×10^{-6} A, output voltage (V_{CE}): 0.75 V

(C) base current (I_B): 6.67×10^{-6} A, output voltage (V_{CE}): 0.55 V

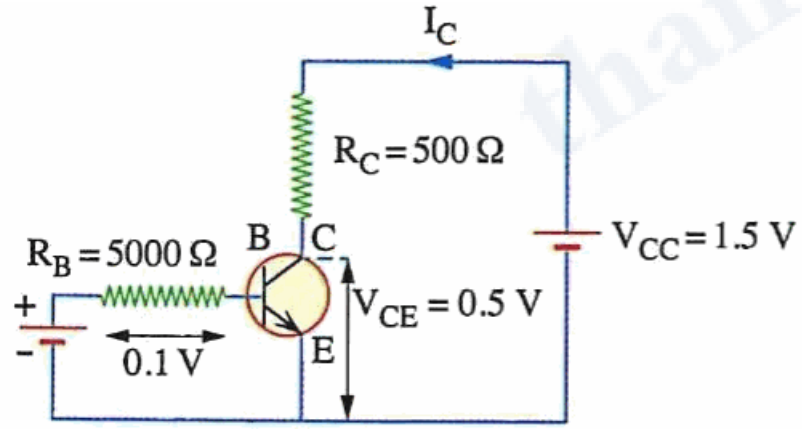
(D) base current (I_B): 6.67×10^{-6} A, output voltage (V_{CE}): 0.75 V

23 The opposite figure shows an (npn) transistor circuit in the closed (on) state. When the resistance taken from the rheostat (S) is increased, the values of the potential differences V_1 and V_2 respectively .....



(A) decrease, decrease
(B) decrease, increase
(C) increase, increase
(D) increase, decrease

24 From the opposite figure, the value of I_E is .....



(A) 2×10^{-3} A
(B) 2.02×10^{-3} A
(C) 2×10^{-5} A
(D) 2.02×10^{-5} A

25 In an npn transistor, if the difference between the collector and base currents $(I_C - I_B)$ is 97 mA and the emitter current (I_E) is 99 mA, the amplification factor (β_e) equals .....

(A) 97
(B) 98
(C) 99
(D) 100

26 In the transistor circuit shown in figure (1), the relation between the ammeter reading (I_C) and the voltmeter reading (V_{CE}) was plotted as in figure (2). The values of R_C and V_{CC} respectively are .....

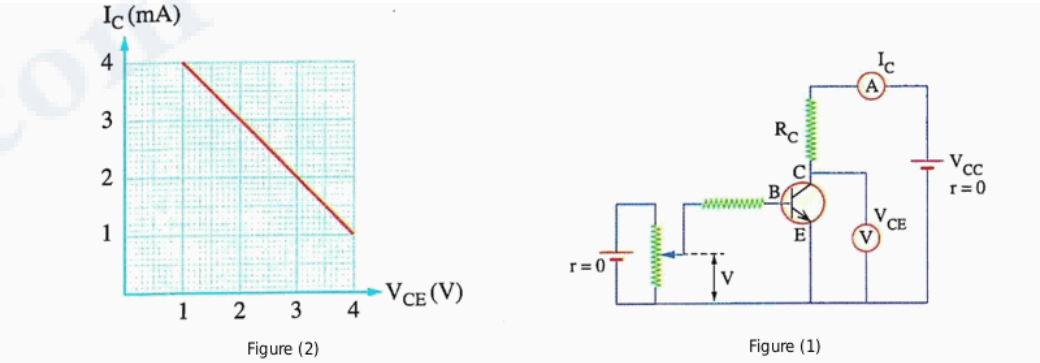
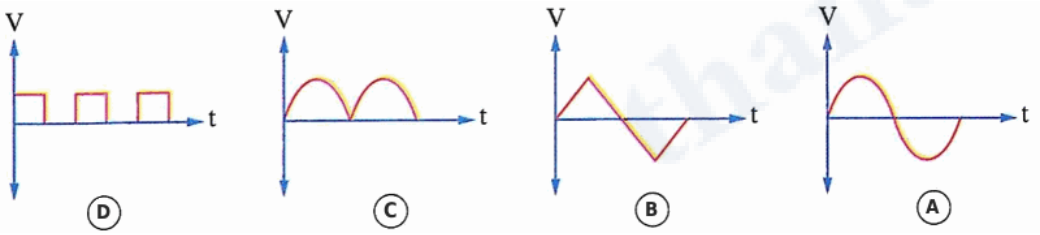


Figure (2) Figure (1)

(A) R_C: 1 kΩ, V_{CC}: 4 V
(B) R_C: 1 kΩ, V_{CC}: 5 V
(C) R_C: 2 kΩ, V_{CC}: 4 V
(D) R_C: 2 kΩ, V_{CC}: 5 V

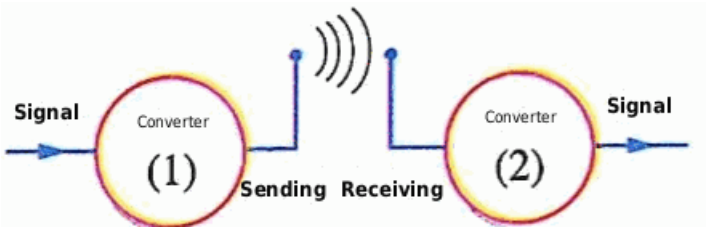
---

27 Which of the following curves shows how the voltage (V) of an electric signal in a digital electronic device changes with time (t)?



---

28 To send and receive signals carrying information in digital electronics, converter (1) is used when sending and converter (2) is used when receiving, so .....



(A) converter (1): analog to digital, converter (2): analog to digital
(B) converter (1): analog to digital, converter (2): digital to analog
(C) converter (1): digital to analog, converter (2): analog to digital
(D) converter (1): digital to analog, converter (2): digital to analog

---

29 Which of the following choices correctly shows the order of the stages of digital sending and receiving?

(A) physical quantity → analog signal → digital signal → analog signal → physical quantity

(B) physical quantity → digital signal → analog signal → digital signal → physical quantity

(C) analog signal → physical quantity → digital signal → physical quantity → analog signal

(D) digital signal → analog signal → physical quantity → analog signal → digital signal

---

30 The binary number equivalent to the decimal number 20 is .....

(A) $(10101)_2$ (B) $(10100)_2$ (C) $(11100)_2$ (D) $(00111)_2$

---

31 The binary number equivalent to the sum of the decimal numbers $(1 + 1 + 1 + 1)$ is .....

(A) $(1111)_2$ (B) $(101)_2$ (C) $(110)_2$ (D) $(100)_2$

---

32 The decimal number equivalent to the binary number $(1010)_2$ is .....

(A) 4 (B) 8 (C) 10 (D) 12

---

33 For the opposite logic gate, the probability that the output is (1) equals .....



(A) 10% (B) 20% (C) 50.9% (D) 87.5%

---

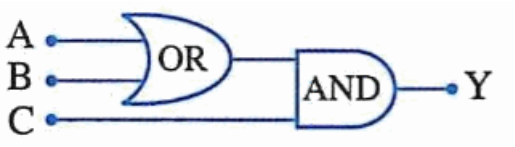
34 The opposite figure shows a logic gate. The number of cases in which the output is (High) equals .....



(A) 0 (B) 1 (C) 2 (D) 3

---

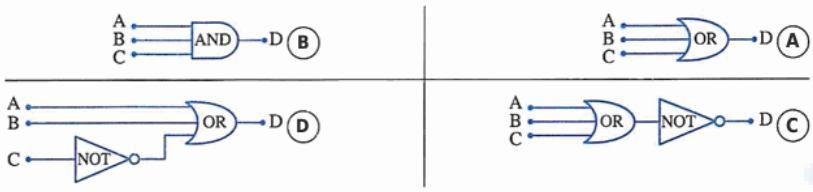
35 For the logic gates shown, so that the output is Y = 1, the input values A, B, C needed are .....



(A) A: 0, B: 1, C: 0 (B) A: 0, B: 0, C: 1 (C) A: 1, B: 0, C: 1 (D) A: 1, B: 0, C: 0

36 Which of the following logic circuits satisfies the opposite truth table?

A	B	C	D
0	0	1	1
0	1	0	1
0	1	1	1

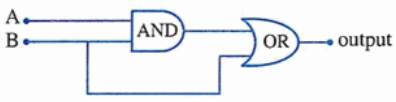


37 The electric signal $(11001)_2$ was fed to the input of an inverter gate. The output signal is .....

(A) $(00111)_2$ (B) $(00110)_2$ (C) $(10101)_2$ (D) $(11001)_2$

38 In the opposite logic circuit, if the input is as shown in the opposite table, the output is .....

A	B
0	0
1	1



output
1
0

(D)

output
0
0

(C)

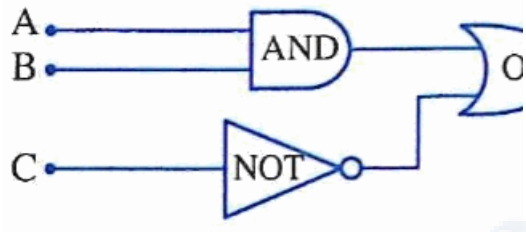
output
1
1

(B)

output
0
1

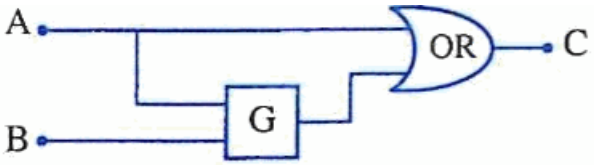
(A)

39 In the logic circuit shown in the figure, which of the following inputs makes the output D = 1?



(A) A: 0, B: 0, C: 1 (B) A: 1, B: 0, C: 1 (C) A: 1, B: 0, C: 0 (D) A: 0, B: 1, C: 1

40 The opposite figure shows a network of logic gates and its truth table. The logic gate G is a(n) ..... gate.



A	B	C
0	0	0
0	1	0
1	0	1
1	1	1

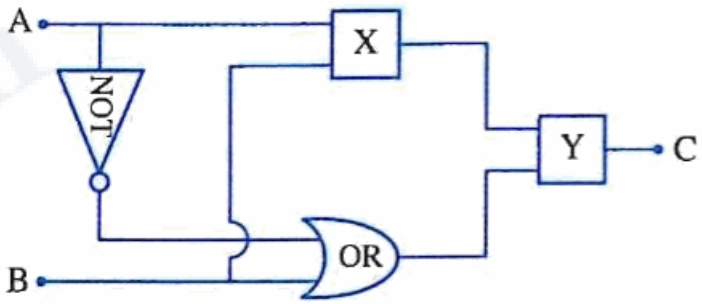
(A) AND (B) OR (C) NOT (D) AND or OR

41 The opposite figure shows a logic circuit. If its output is (1) when the input on A, B is $(0, 0)$, then the gates X and Y respectively are .....



(A) gate X: OR, gate Y: AND
(B) gate X: NOT, gate Y: AND
(C) gate X: NOT, gate Y: NOT
(D) gate X: NOT, gate Y: OR

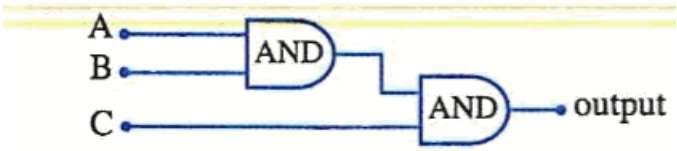
42 The opposite figure shows a network of logic gates and its truth table. The gates X and Y are .....



A	B	C
0	0	1
0	1	1
1	0	0
1	1	1

(A) gate X: OR, gate Y: AND
(B) gate X: AND, gate Y: AND
(C) gate X: OR, gate Y: OR
(D) gate X: AND, gate Y: OR

43 The opposite figure shows a logic circuit, and the truth table after it shows some input and output values of this circuit. The values of x, y, z in the table are .....

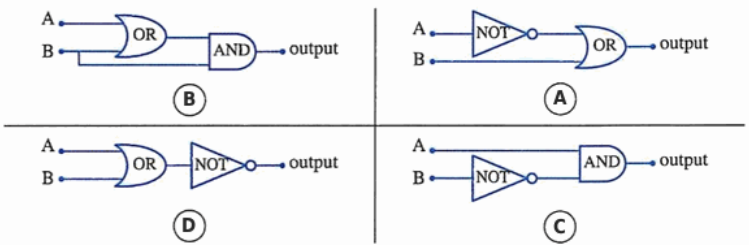


input			output
A	B	C	
x	1	1	0
1	1	0	y
1	z	1	1

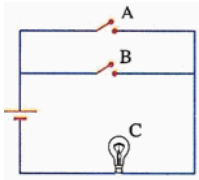
(A) x: 0, y: 0, z: 0
(B) x: 1, y: 0, z: 0
(C) x: 0, y: 0, z: 1
(D) x: 0, y: 1, z: 1

44 Which of the following logic circuits satisfies the opposite truth table?

A	B	output
0	0	1
0	1	1
1	0	0
1	1	1



45 In the electric circuit shown in the opposite figure, the two switches (A) and (B) are the inputs of a logic gate and the lamp (C) is its output. The correct truth table of this gate is .....



A	B	C
1	0	0
0	1	0

D

A	B	C
1	0	1
0	1	1

C

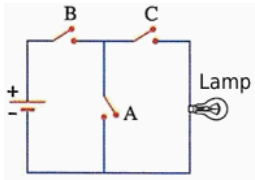
A	B	C
0	1	0
1	1	1

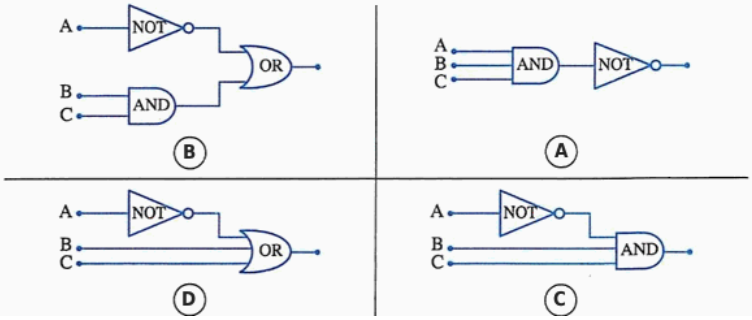
B

A	B	C
0	1	1
1	1	0

A

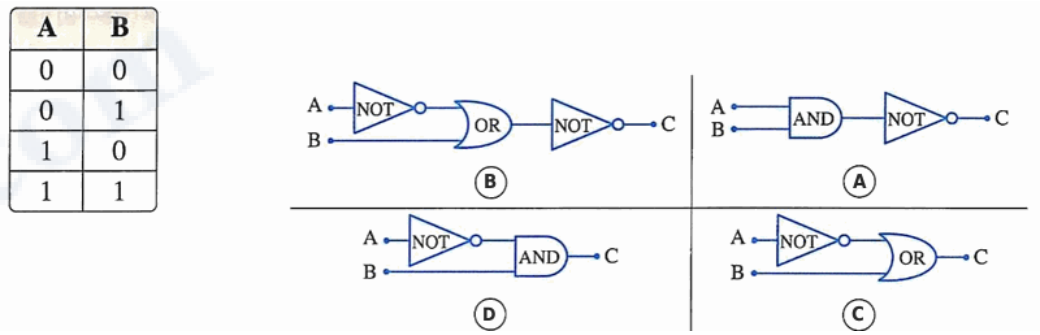
46 Which of the following logic gates represents the opposite electric circuit?





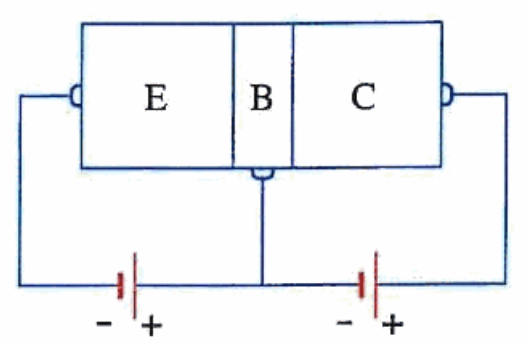
47 In which of the following logic gates is the output a decimal number equal to 11 when the opposite input table is used?

A	B
0	0
0	1
1	0
1	1



Essay questions — 29 questions

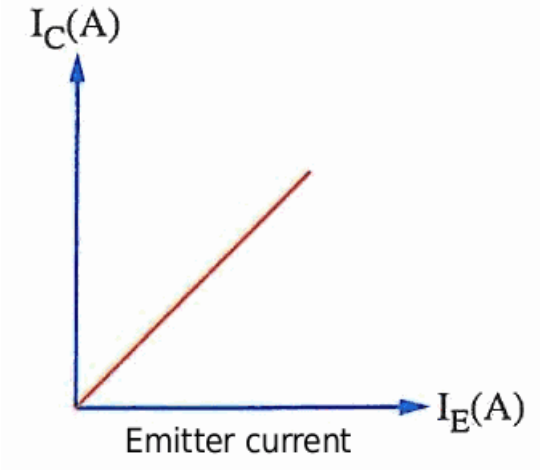
1 The opposite figure shows the regions of an npn transistor. Explain what happens to the free electrons in each region when it is connected as in the figure.



2 Give a reason: in a transistor, the distribution constant (α_e) is close to one, while the amplification ratio (β_e) is greater than one.

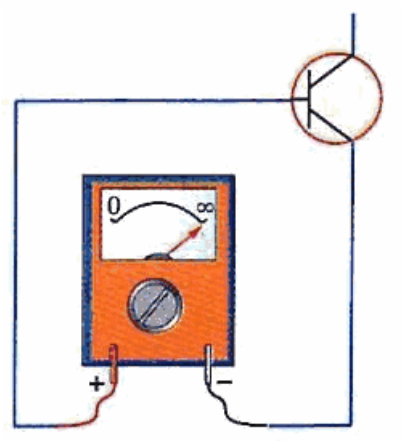
3 Compare between the emitter and the collector of an npn transistor connected in a common base circuit (in terms of: the valency of the impurity atoms - the type of connection with the base - the barrier voltage with the base).

4 Write the mathematical relation between the two variables in the opposite graph, and state what the slope of the straight line equals.



5 What conditions must an npn transistor meet to work as a closed (on) switch?

6 A transistor was connected to an ohmmeter and the deflection of the meter was as shown in the opposite figure. What type is the transistor (npn or pnp)? Explain.



7 When an npn transistor was used in a common emitter circuit as an amplifier, the collector current was 99 mA and the product of the distribution ratio (α_e) and the amplification factor (β_e) was 98.01. Calculate:

(1) the base current (I_B).

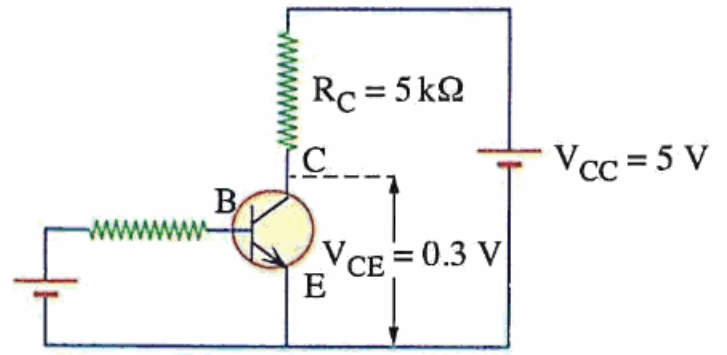
(2) the emitter current (I_E).

8 In a common emitter transistor circuit, prove that: $I_B = I_C\ (1/(\alpha_e) - 1)$

9 In the opposite transistor circuit, if the amplification factor is 30, calculate:

(1) the base current (I_B).

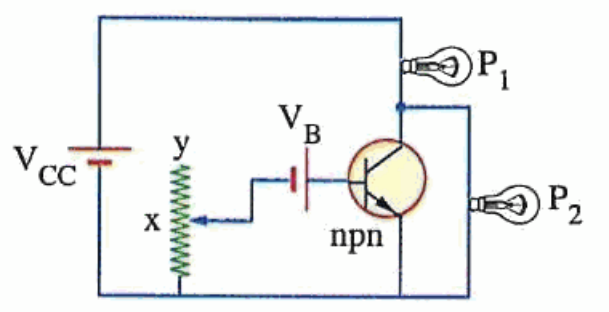
(2) the distribution constant (α_e).



10 The opposite figure shows an npn transistor circuit working as a closed switch, with two identical lamps P_1 and P_2:

(1) What happens, with explanation, to the brightness of the two lamps when the slider is moved from point x towards point y?

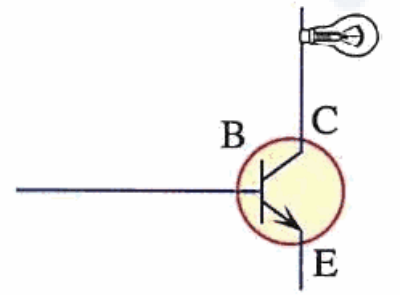
(2) Draw the graph of the relation between the potential difference (V_1) across lamp P_1 and the potential difference (V_2) across lamp P_2



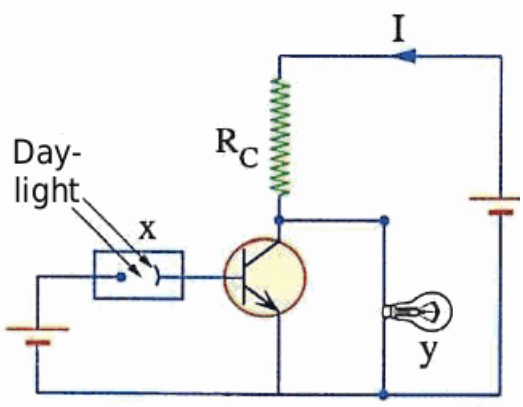
11 The opposite figure shows a transistor connected in series with a small lamp that works on a DC voltage:

(1) Complete the circuit diagram so that the lamp lights.

(2) What change would you make to the circuit in the previous case so that the lamp does not light?



12 In the opposite electronic circuit, a photocell (x) is connected to the base of an npn transistor, and the emitter and collector of the transistor are connected to an electric lamp (y). Explain why the lamp lights when daylight is gone.



13 Give a reason:

(1) There are defects in sound and picture in analog transmission.

(2) Digital electronics are preferred to analog electronics in electronic devices.

14 What is the scientific idea on which digital electronics are based?

15 Find the binary number equivalent to each of the following decimal numbers:

(1) 59

(2) 120

16 Find the decimal number equivalent to each of the following binary numbers:

(1) $(100110)_2$

(2) $(10011011)_2$

17 Find the decimal number for the quotient of the two binary numbers $((11110)_2)/((110)_2)$

18 Deduce the truth table of a circuit made of:

(1) a two-input AND followed by an inverter.

(2) a two-input OR followed by an inverter.

19 Complete the truth table of the following electronic circuits and convert the output to a decimal number:

Circuit (1)

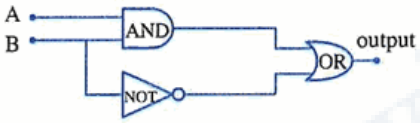
A	B	C	output
1	1	0	.....
1	0	1	.....
0	0	1	.....



20 Complete the truth table of the following electronic circuits and convert the output to a decimal number:

Circuit (2)

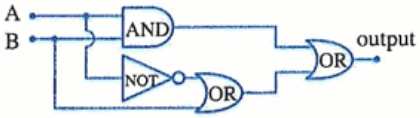
A	B	output
0	0	.....
0	1	.....
1	0	.....
1	1	.....



21 Complete the truth table of the following electronic circuits and convert the output to a decimal number:

Circuit (3)

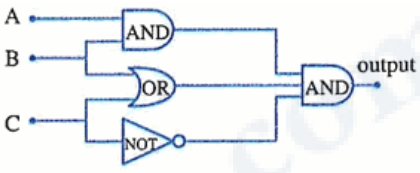
A	B	output
0	0	.....
0	1	.....
1	0	.....
1	1	.....



22 Complete the truth table of the following electronic circuits and convert the output to a decimal number:

Circuit (4)

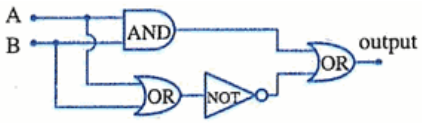
A	B	C	output
0	0	0	.....
1	1	0	.....
1	0	1	.....
0	1	1	.....
0	0	1	.....
1	1	1	.....



23 Complete the truth table of the following electronic circuits and convert the output to a decimal number:

Circuit (5)

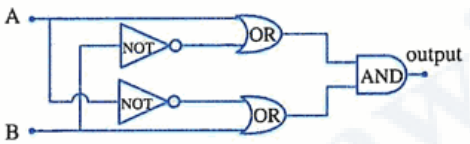
A	B	output
0	0	.....
0	1	.....
1	0	.....
1	1	.....



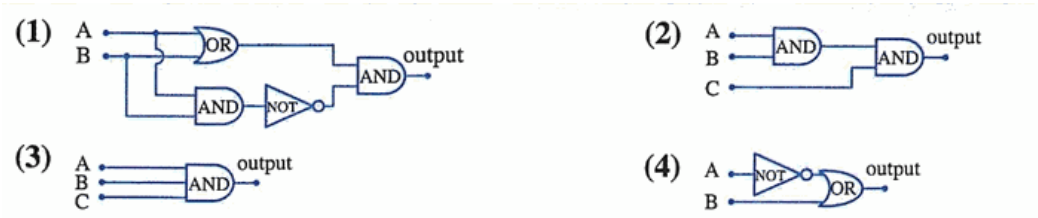
24 Complete the truth table of the following electronic circuits and convert the output to a decimal number:

Circuit (6)

A	B	output
0	0	.....
0	1	.....
1	0	.....
1	1	.....



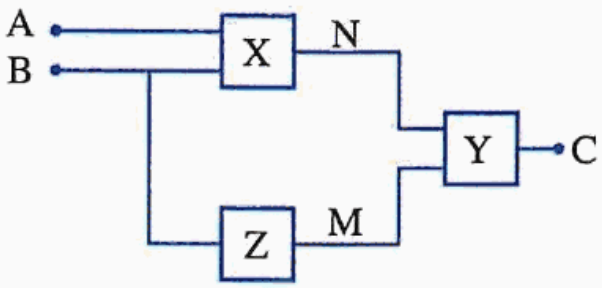
25 Write the truth table of the following logic circuits:



26 From the following truth table:

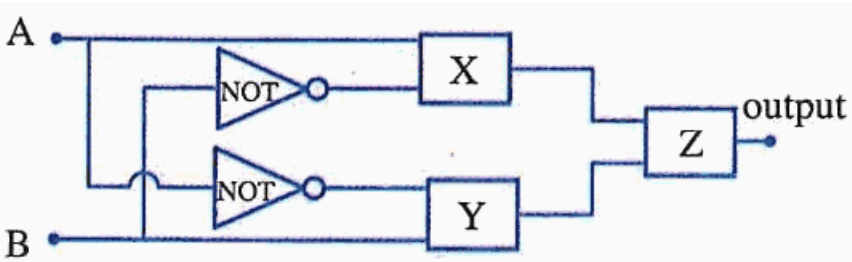
(1) Deduce the types of the gates X, Y, Z

(2) Complete the table.



Input				Output
A	B	N	M	C
0	1	1	0	0
1	1	.....	0	.....
1	0	1	.....	1

27 From the following truth table, deduce the types of the gates X, Y, Z:



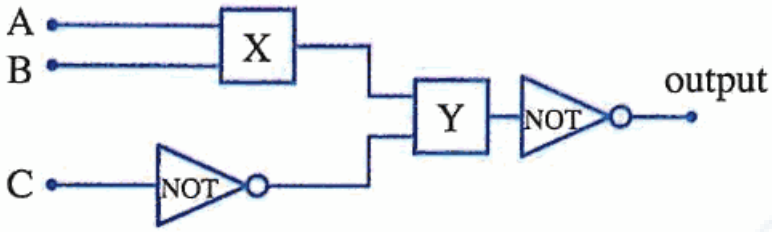
A	B	output
0	0	0
0	1	1
1	0	1
1	1	0

28 The truth table in front of you gives some input and output values of the gate circuit shown in the figure:

(1) Identify the type of gate X and gate Y

(2) Find the output Z in the table.

A	B	C	output
1	1	1	0
0	1	1	1
0	0	0	Z

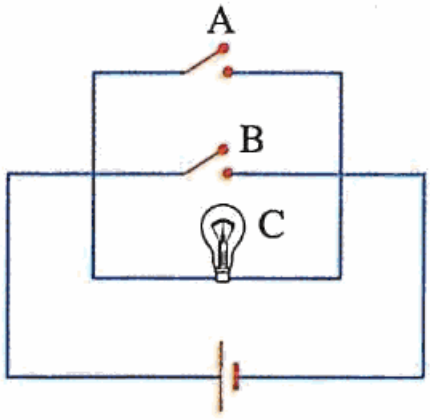


29 The electric circuit shown in the figure works like a group of logic gates, where the switches A and B are the inputs and the lighting of lamp C is the output:

(1) Complete the opposite truth table.

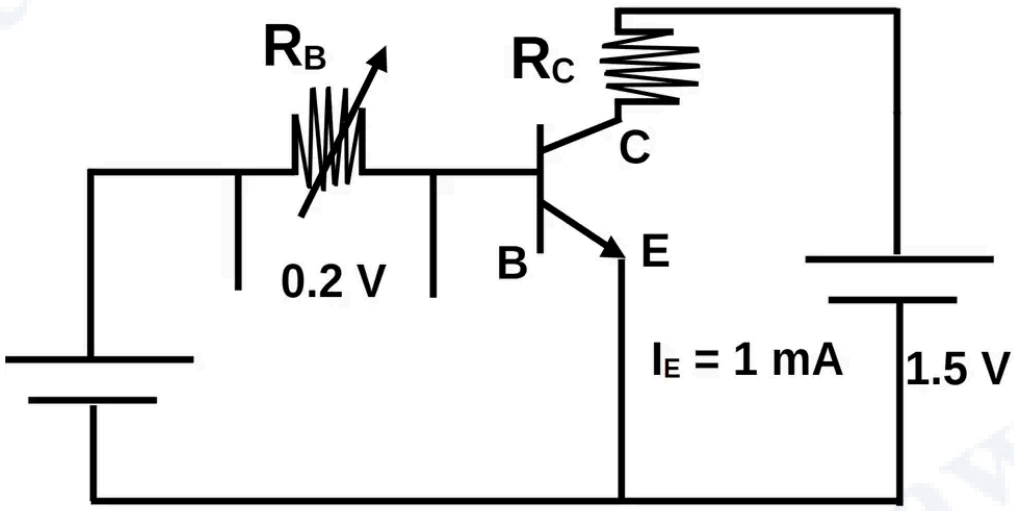
(2) Draw the logic gate circuit that satisfies the opposite truth table.

input		output
A	B	(C)
1	1	.....
0	1	.....
1	0	.....
0	0	.....



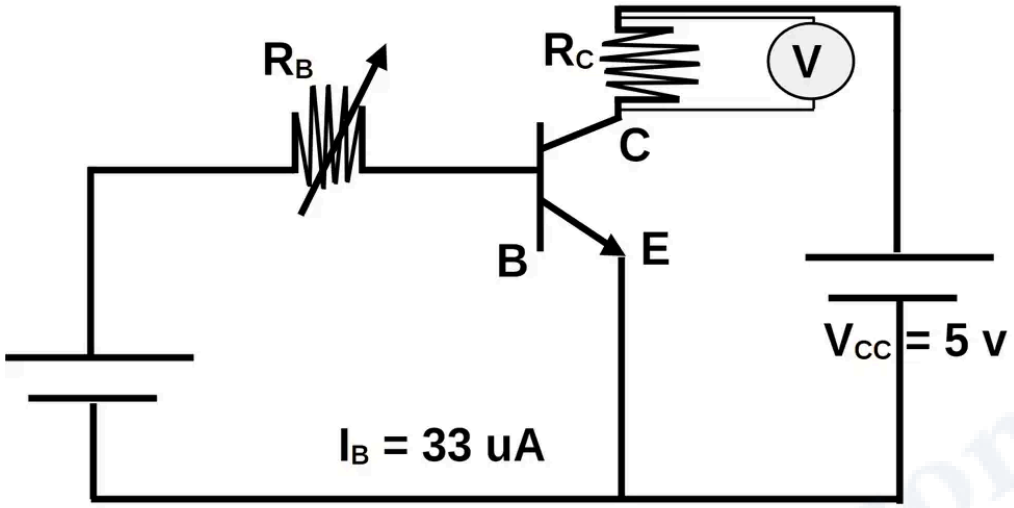
Past exam questions — 34 questions

1 The opposite circuit is a transistor circuit of an inverter gate. If the output voltage (V_{CE}) is 0.8V when the base circuit resistance (R_B) is 4000Ω, the collector circuit resistance (R_C) is about ... (Trial exam / June 2021)



(A) $73.7 \times 10^2\ \Omega$ (B) $7370 \times 10^2\ \Omega$ (C) $7.37 \times 10^2\ \Omega$ (D) $0.737 \times 10^2\ \Omega$

2 The figure shows a transistor working as an amplifier. If the voltmeter reading is 4.8V and R_C is 4.5kΩ, the values of the two constants α_E and β_E respectively are ... (Trial exam / June 2021)



(A) 0.97 , 32.32 (B) 0.95 , 33.67 (C) 0.99 , 99 (D) 0.75 , 3

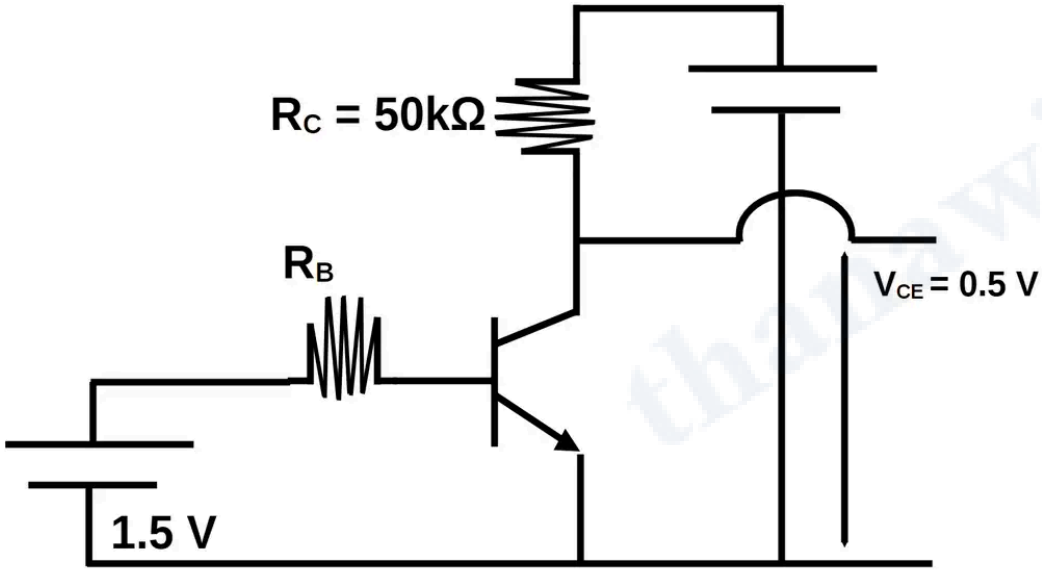
3 If the base current in an npn transistor is 2mA and α_E is 0.97, the collector current is ... (1st session 2021, Sample exam 2025)

(A) 1.97 mA (B) 64.67 mA (C) 10 mA (D) 50.67 mA

4 When an npn transistor is used as a current amplifier, if the base current is 1mA and the current amplification ratio (β_e) is 200, the collector current is ... (1st session 2021)

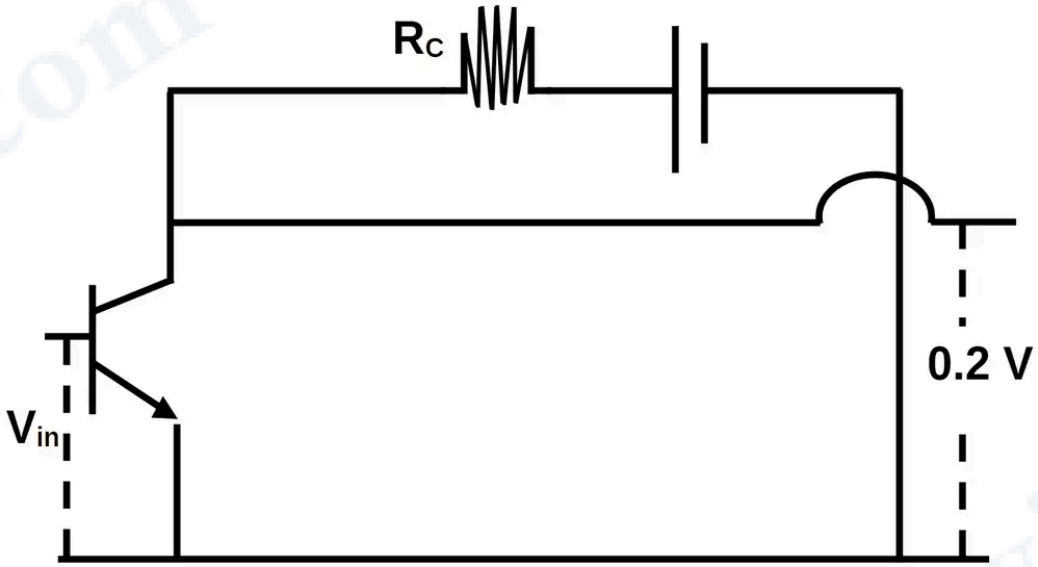
(A) 0.02 A (B) 2 A (C) 0.2 A (D) 20 A

5 The opposite figure shows an npn transistor circuit whose amplification factor β_e is 30. If R_C is 50kΩ, the base current (I_B) is ... (2nd session 2021)



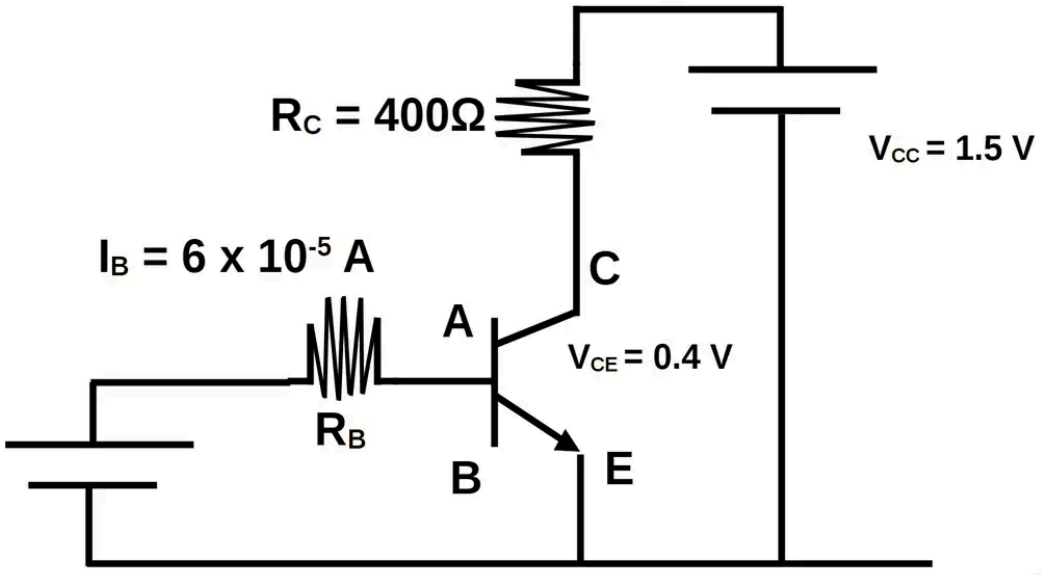
(A) 3×10^{-6} (B) 9.3×10^{-5} (C) 8.7×10^{-6} (D) 9×10^{-5}

6 In the opposite circuit the transistor is used as a switch. If the output voltage (V_{CE}) is 0.2V and the battery voltage in the collector circuit is 1.5V, the potential difference across the collector resistance (R_C) is ... (2nd session 2021)



(A) 1.7 V (B) 1.3 V (C) 0.3 V (D) 7.5 V

7 The figure shows an (npn) transistor used as an amplifier. The ratio $((\alpha_e)/(\beta_e))$ = ... (1st session 2022)



(A) 2.7×10^{-3} (B) 2.1×10^{-2} (C) 1.1×10^{-2} (D) 2.8×10^{-3}

8 If the distribution ratio (α_e) of a transistor is 0.99, the ratio I_E/I_B = ... (2nd session 2022)

(A) 100 (B) 99 (C) 200 (D) 198

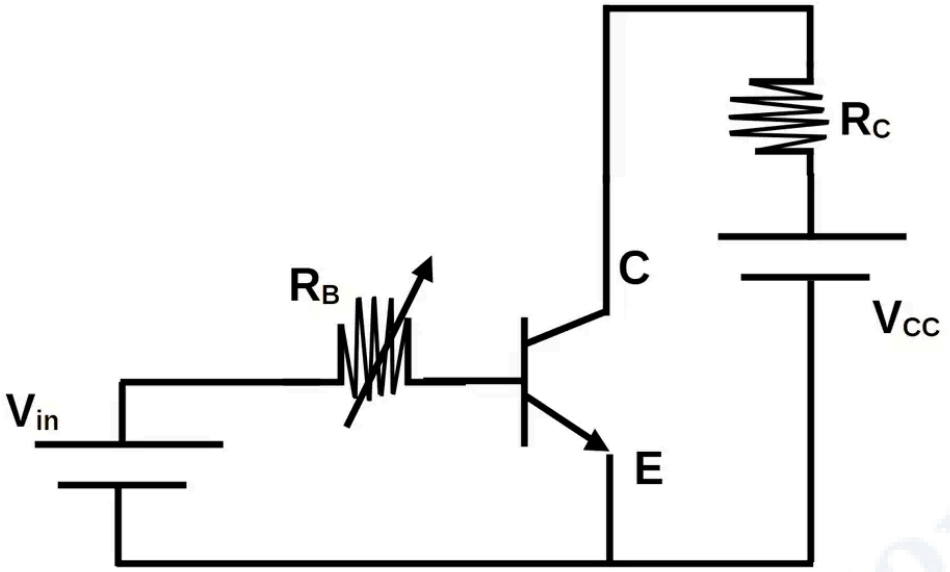
9 If the base current in an npn transistor is 6uA and $(\alpha_e = 0.95)$, the currents through the emitter and the collector respectively are ... (Trial exam 2023)

I_C	I_E	
114 uA	120 uA	A
120 uA	114 uA	B
11.4 uA	12 uA	C
240 uA	242 uA	D

10 In a transistor circuit, if the emitter current is 120 times the base current, the value of the constant (α_e) ... (1st session 2023)

(A) 0.96 (B) 120 (C) 119 (D) 0.99

11 The circuit in the figure shows a transistor used as a switch. When R_B is doubled, which choice correctly describes what happened to V_{CC}? (2nd session 2023)

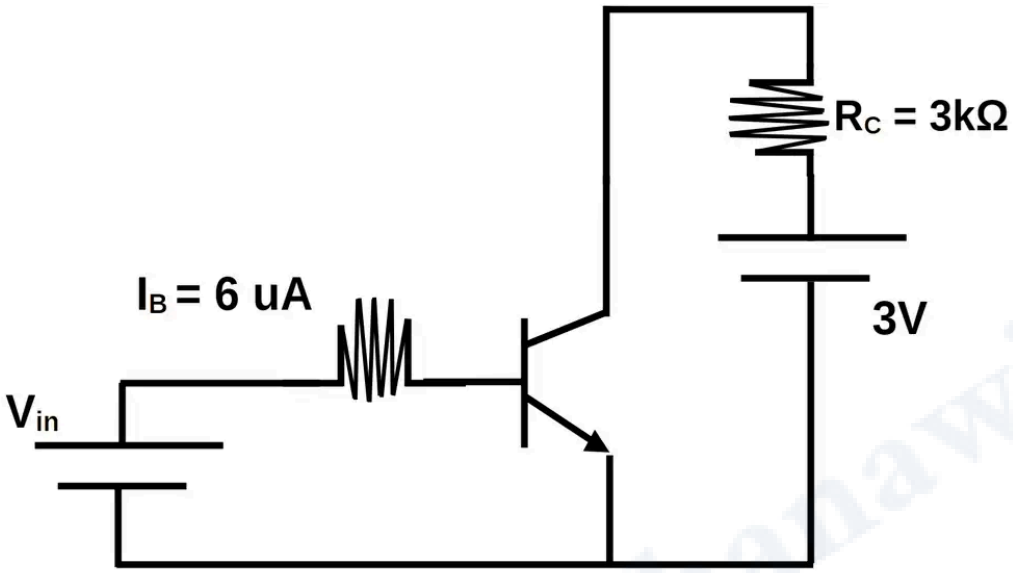


(A) it stays constant (B) it is halved (C) it is doubled (D) it equals zero

12 A transistor has a current amplification ratio (β_e) of 150, so the value of the constant (α_e) is ... (2nd session 2023)

(A) 1.01 (B) 0.99 (C) 0.97 (D) 1.1

13 The figure shows an (npn) transistor circuit with amplification factor $(\beta_e = 99)$. The collector current (I_C) and the output voltage (V_{CE}) respectively are ... (1st session 2024)

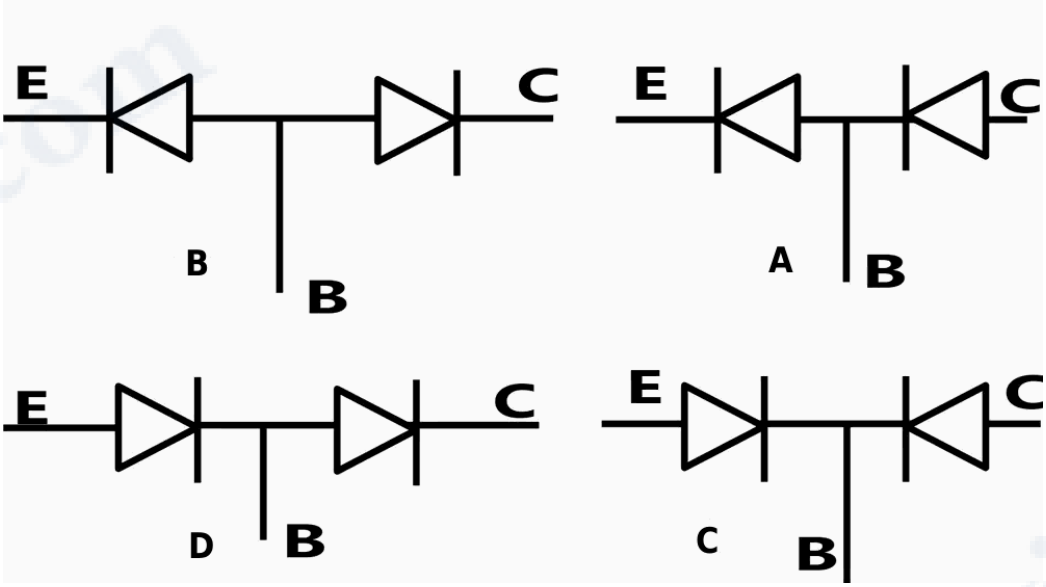


(A) 2.982 V , 0.06 uA (B) 1.782 V , 16.5 uA
(C) 1.218 V , 594 uA (D) 2.982 V , 16.5 uA

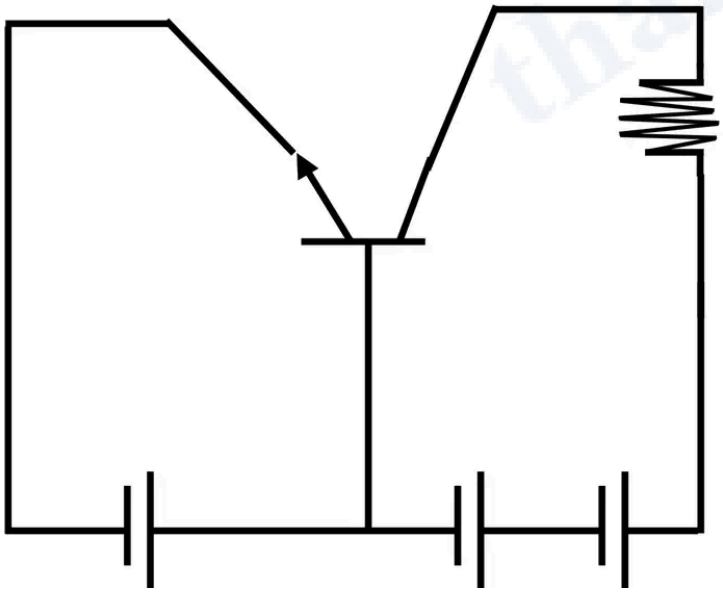
14 If the amplification factor is $(\beta_e = 93.6)$, the ratio (I_E/I_B) = ... (2nd session 2024)

(A) 93.6 (B) 95.6 (C) 94.6 (D) 92.6

15 An npn transistor can be considered equivalent to two diodes connected together. Which of the following figures is the correct equivalent of the npn transistor? (Sample exam 2025)



16 A transistor is connected as shown in the figure. Which of the following choices correctly describes the use of the transistor in this circuit? (Sample exam 2025)



(A) It amplifies both the electric power and the electric current

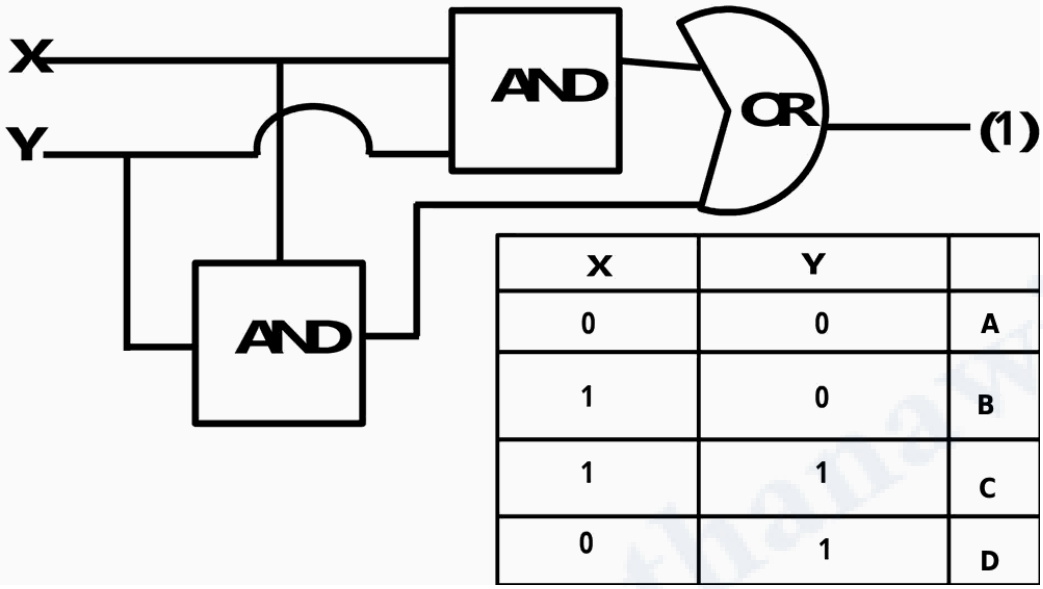
(B) It amplifies the electric power but not the electric current

(C) It amplifies the electric current but not the electric power

(D) It amplifies neither the electric power nor the electric current

17 In a transistor circuit, $(V_{CC} = 1.5V)$ and the potential difference between the collector and the emitter is $(V_{CE} = 0.5V)$ (Sample exam 2025)
and the collector circuit resistance is $(R_C = 500\ \Omega)$.
Calculate the collector current (I_C).

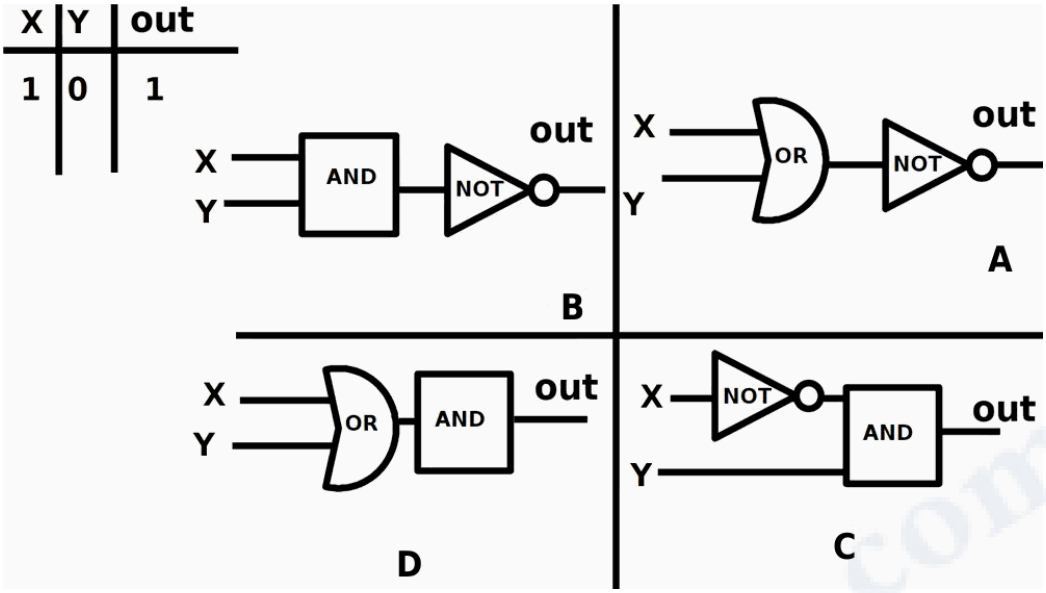
18 A group of logic gates has an output voltage of (1) as in the figure. Which of the cases shown in the table gives this? (Trial exam / June 2021)



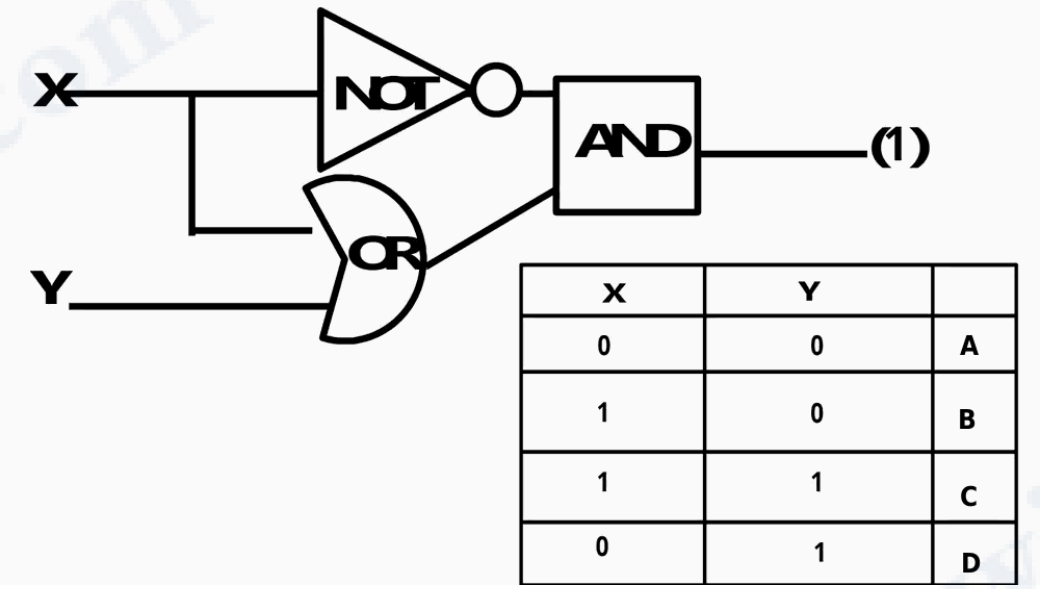
X	Y	
0	0	A
1	0	B
1	1	C
0	1	D

19 Which of the following logic circuits gives the input and output voltages shown in the opposite table? (1st session 2021)

X	Y	out
1	0	1

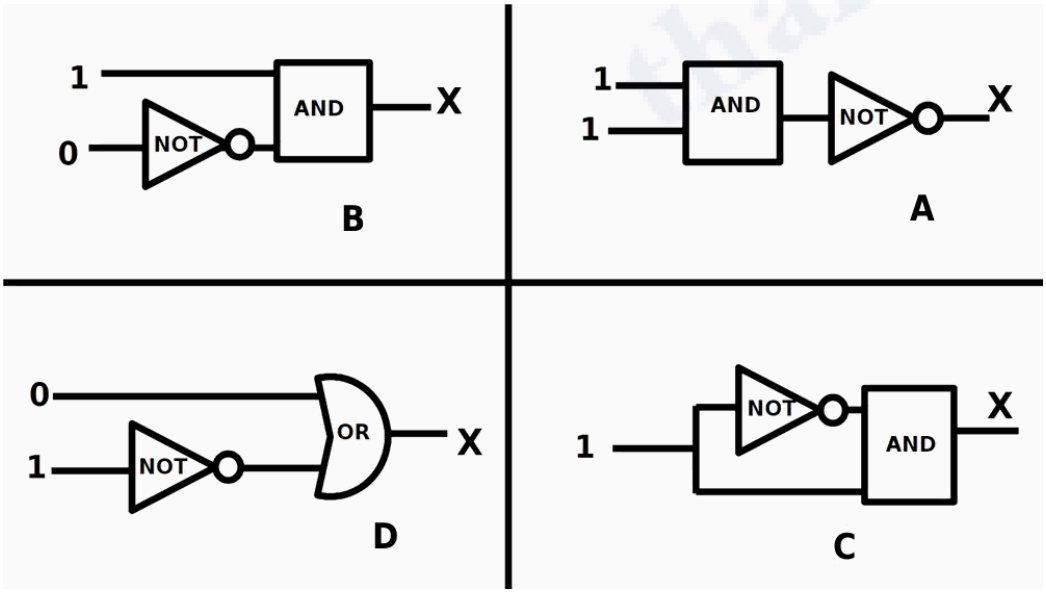


20 A group of logic gates has an output voltage of (1) as in the figure. Which of the choices shown in the table for the two input voltages X, Y gives this? (2nd session 2021, 1st session 2022)

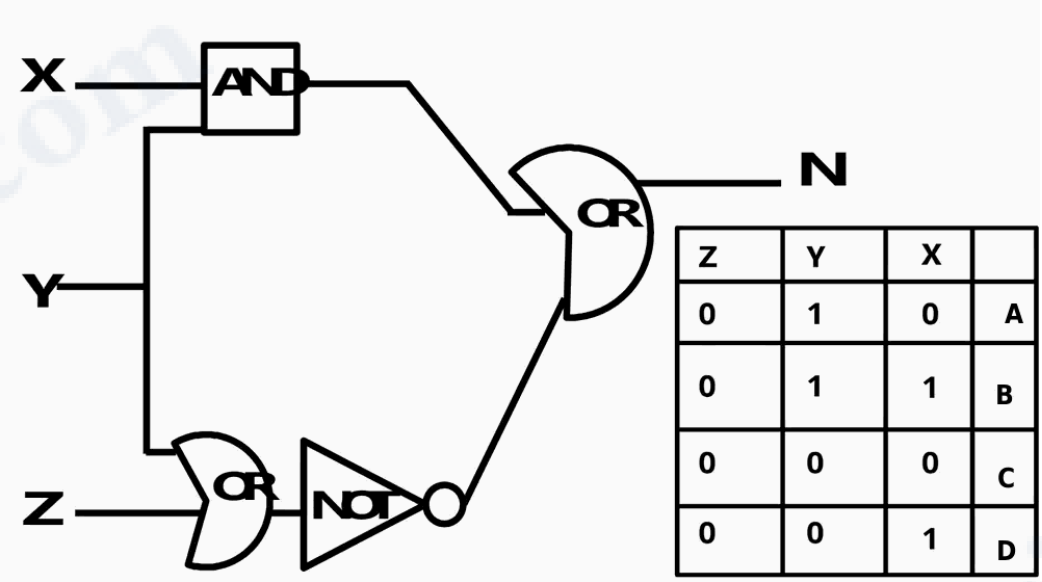


X	Y	
0	0	A
1	0	B
1	1	C
0	1	D

21 In which of the following logic circuits is the output voltage X high? (2nd session 2022)

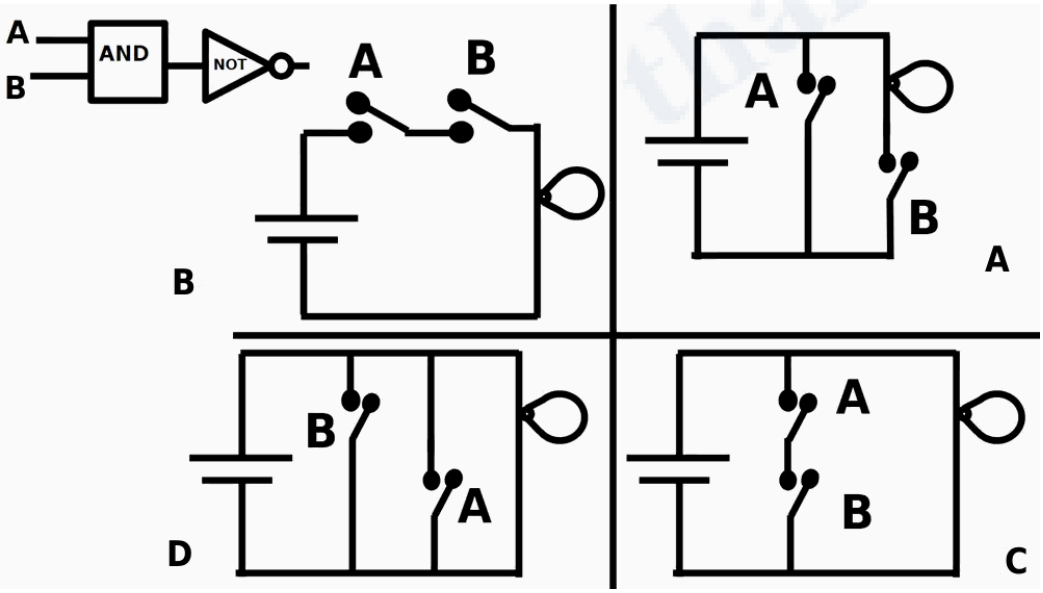


22 In the logic gate circuit shown in the figure, which of the following choices makes the output (N) equal (0)? (Trial exam 2023)

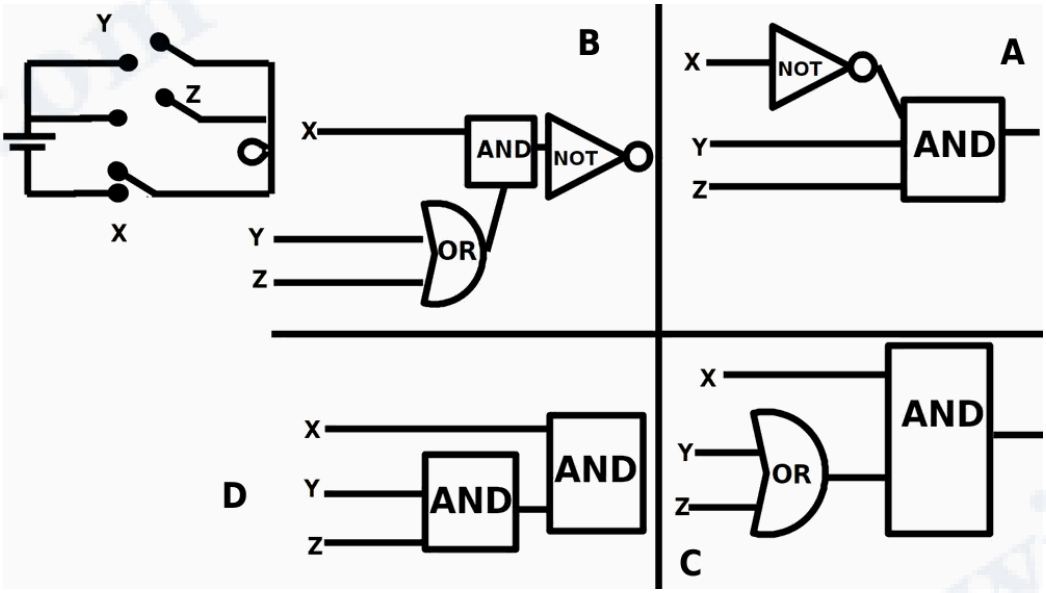


Z	Y	X	
0	1	0	A
0	1	1	B
0	0	0	C
0	0	1	D

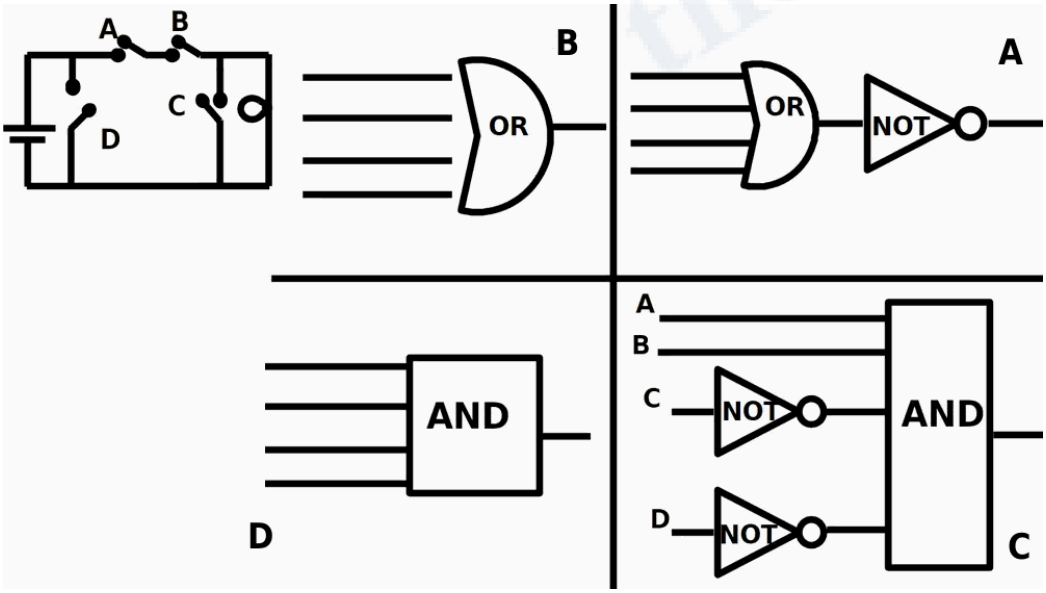
23 Which of the following electric circuits represents the work of the group of logic gates shown in the opposite figure? (1st session 2023)



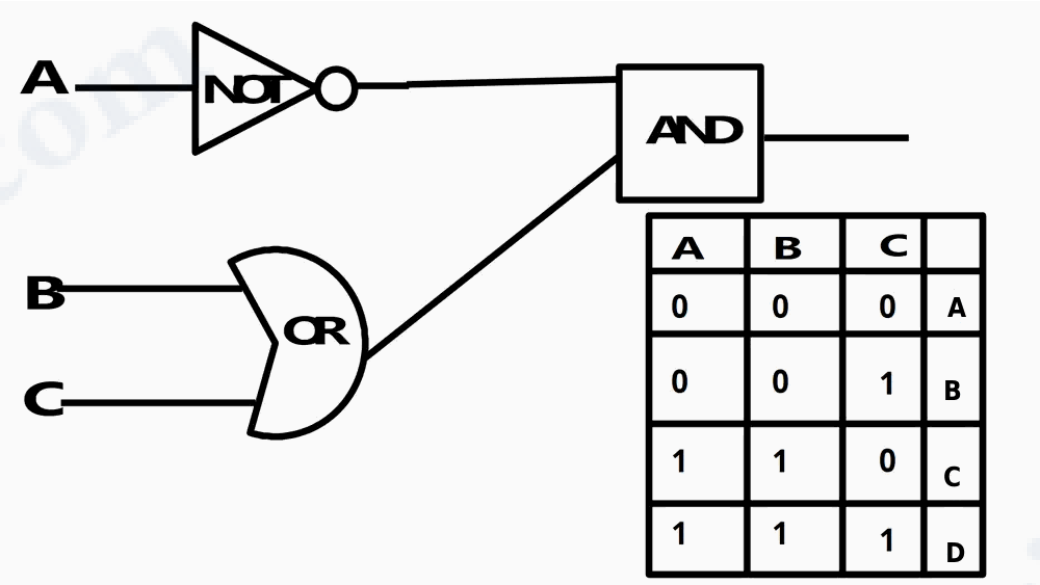
24 The figure shows an electric circuit where X, Y, Z are switches that are the inputs of a logic gate circuit, and the electric lamp is the output. Which of the groups shown does this circuit represent? (2nd session 2023)



25 The figure shows an electric circuit equivalent to a logic gate circuit. Which of the following logic gate circuits does this electric circuit work like? (1st session 2024)



26 The opposite figure shows several logic gates connected together. Which of the following choices gives a high output? (2nd session 2024)

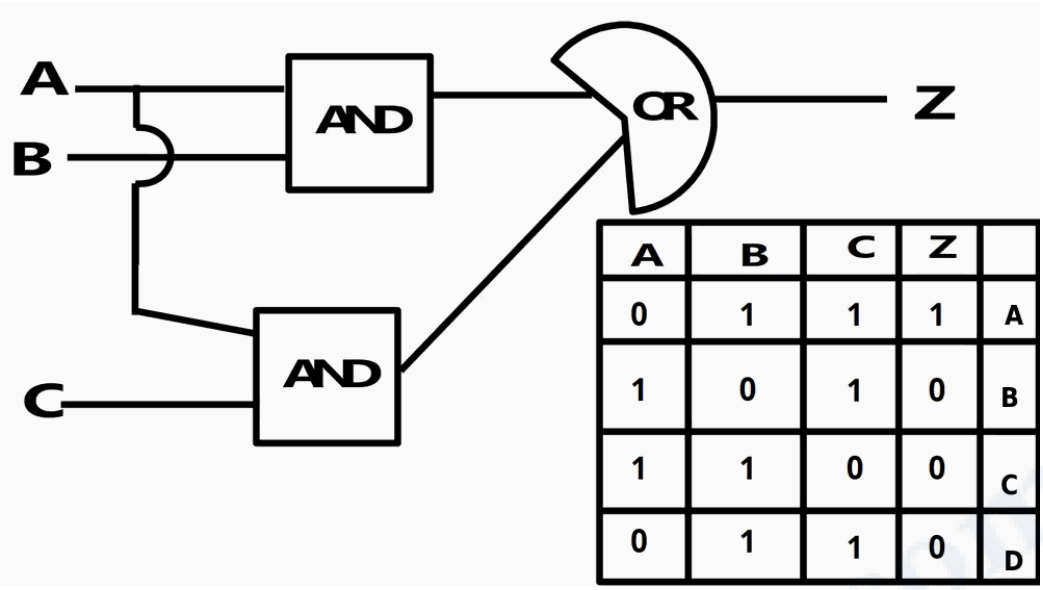


A	B	C	
0	0	0	A
0	0	1	B
1	1	0	C
1	1	1	D

27 The logic gate whose electric circuit has two switches connected in parallel is the ..... gate (Sample exam 2025)

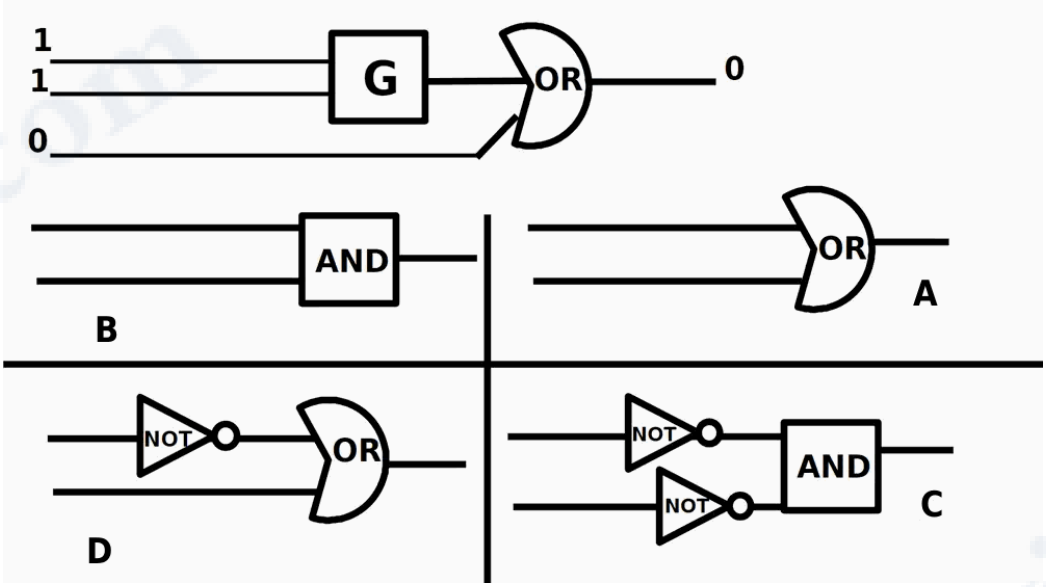
(A) NOT (B) AND (C) OR (D) NOT or AND

28 A group of logic gates is connected together as shown in the figure. Which of the following choices can be obtained from this group? (Sample exam 2025)

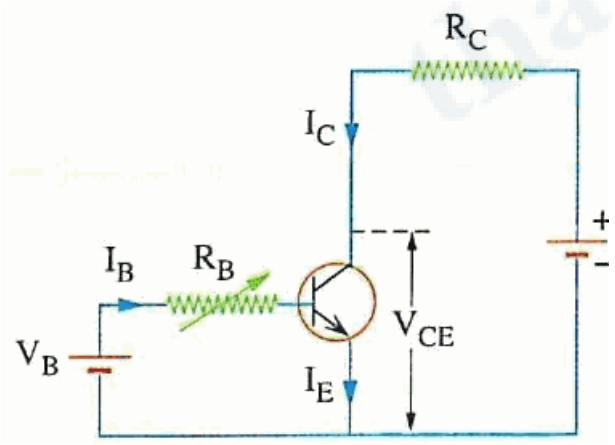


A	B	C	Z	
0	1	1	1	A
1	0	1	0	B
1	1	0	0	C
0	1	1	0	D

29 The figure shows part of a circuit with several logic gates, where the output is (Low) when the input is as shown. So (G) may be ... (Sample exam 2025)



30 The figure shows an npn transistor circuit. What is the effect of increasing the variable resistance (R_B) on the collector current (I_C) and the output voltage (V_{CE})? (1st session 2025)



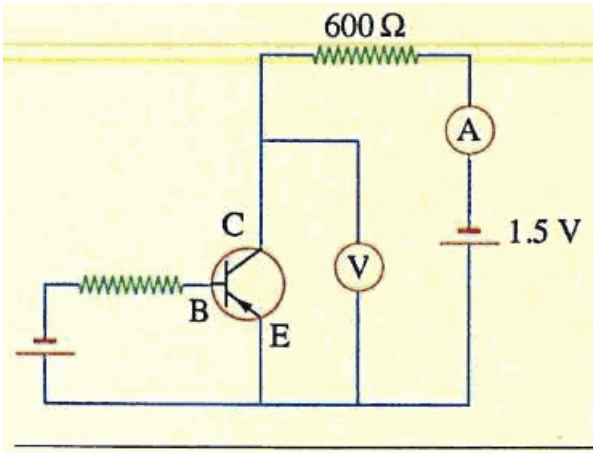
(A) collector current: increases, output voltage: increases

(B) collector current: decreases, output voltage: increases

(C) collector current: does not change, output voltage: decreases

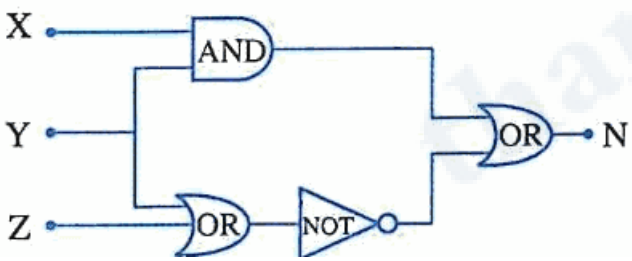
(D) collector current: decreases, output voltage: does not change

31 In the transistor circuit shown in the figure, the ammeter reads 2 mA, so the voltmeter reading equals ..... (2nd session 2025)



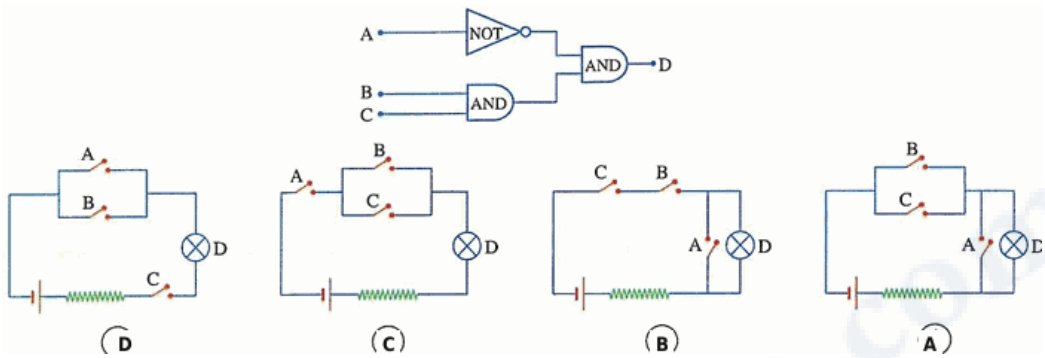
(A) 0.9 V (B) 0.3 V (C) 0.6 V (D) 0.5 V

32 The figure shows a group of logic gates connected together. Which of the following input values makes the output (N) equal (zero)? (1st session 2025)

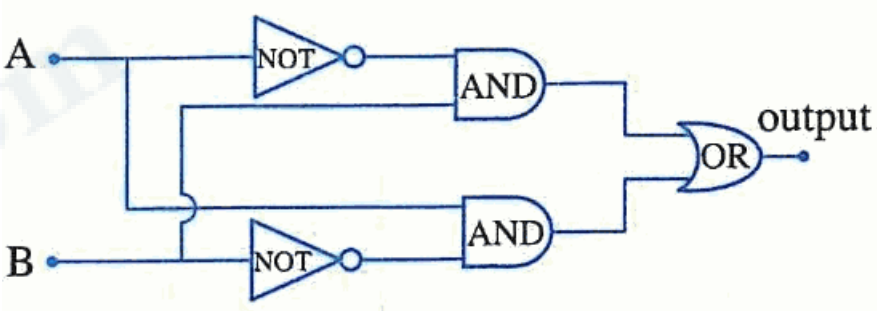


(A) X = 0, Y = 1, Z = 0 (B) X = 1, Y = 1, Z = 0
(C) X = 1, Y = 1, Z = 1 (D) X = 0, Y = 0, Z = 0

33 The figure shows a group of logic gates connected together. Which of the following electric circuits represents the work of this group of gates? (2nd session 2025)



34 The figure shows some logic gates connected to each other. The number of cases in which the output is (high) is ..... (Sample exam 2026)



(A) 0 (B) 1 (C) 2 (D) 3

Answer key and solutions

Multiple choice questions

1 D	2 D	3 B	4 B	5 B	6 D	7 B	8 A	9 C	10 D
11 A	12 B	13 D	14 D	15 D	16 B	17 B	18 D	19 B	20 C
21 D	22 D	23 B	24 B	25 B	26 B	27 D	28 B	29 A	30 B
31 D	32 C	33 D	34 B	35 C	36 A	37 B	38 A	39 C	40 A
41 D	42 D	43 C	44 A	45 C	46 C	47 C			

1 **Answer (D)**

The base is very thin and its impurity concentration is low.

2 **Answer (D)**

The majority carriers in the emitter and collector of a pnp transistor are holes.

3 **Answer (B)**

An npn transistor has two diode junctions: emitter-base and base-collector.

4 **Answer (B)**

In common emitter, the transistor is an open switch when the base is negative,
which is figure (2).

5 **Answer (B)**

The emitter is heavily doped and the collector less,
so the ratio is greater than one.

6 **Answer (D)**

$\alpha_e < 1$, $\beta_e > 1$

$\alpha_e = (\beta_e)/(1+\beta_e)$

All the statements are true.

7 **Answer (B)**

The base is large and positive: the transistor reaches saturation and works as a closed switch.

8 **Answer (A)**

$I_E = 18/0.9 = 20\ mA$

$I_B = I_E - I_C = 2\ mA$

9 **Answer (C)**

$\beta_e = I_C/I_B = 45/0.45 = 100$

$\alpha_e = (\beta_e)/(1+\beta_e) = 100/101 = 0.99$

10 **Answer (D)**

$I_B = 45/100 = 0.45\ mA$

$I_E = I_C + I_B = 45.45\ mA$

11 **Answer (A)**

$\alpha_e = 96/100 = 0.96$

$\beta_e = (\alpha_e)/(1-\alpha_e) = 24$

12 **Answer (B)**

$\beta_e = (\alpha_e)/(1-\alpha_e) = 99$

$I_C = \beta_e\ I_B = 99 \times 100 \times 10^{-6}$

$I_C = 9.9 \times 10^{-3}\ A$

13 **Answer (D)**

$I_C = \beta_e\ I_B = 24 \times 24\ \mu A = 576 \times 10^{-6}\ A$

$\alpha_e = 24/25 = 0.96$

14 **Answer (D)**

$\beta_e = (10\ mA)/(200\ \mu A) = 50$

$\alpha_e = 50/51 = 0.98$

15 **Answer (D)**

$\alpha_e = 99/100 = 0.99$

$I_E = I_C/(\alpha_e) = 10/0.99 = 10.1\ mA$

16 **Answer (B)**

The voltage across the resistor is the difference between V_CC and V_CE.

$I_C = (V_{CC}\text{-}V_{CE})/R_C = (1.5\text{-}0.5)/500$

$I_C = 2 \times 10^{-3}\ A$

17 **Answer (B)**

Increasing R1 decreases the base current, so the collector current decreases,

so the voltmeter reading decreases but does not reach zero, because the transistor is still working.

18 **Answer (D)**

Common emitter, the base is positive, and the large battery makes the collector positive.

19 **Answer (B)**

Both batteries are connected to the lower emitter: common emitter.

20 **Answer (C)**

$\beta_e = 98/2 = 49$

$I_E = 98 + 2 = 100\ mA$

$\alpha_e = 98/100 = 0.98$

21 **Answer (D)**

$I_C = (1.2\text{-}0.024)/400 = 2.94\ mA$

$\beta_e = 2.94/0.06 = 49$

$\alpha_e = 49/50 = 0.98$

22 **Answer (D)**

$I_B = 0.01/1500 = 6.67 \times 10^{-6}\ A$

$I_C = 75 \times 6.67 \times 10^{-6} = 0.5\ mA$

$V_{CE} = 3\text{-}0.5 \times 10^{-3} \times 4500$

$V_{CE} = 0.75\ V$

23 **Answer (B)**

Increasing R_B decreases the base current, so the collector current decreases,

so V1 decreases because it equals I_C R_C,

and V2 increases because V_CC is constant.

24 **Answer (B)**

$I_B = 0.1/5000 = 2 \times 10^{-5}\ A$

$I_C = (1.5\text{-}0.5)/500 = 2 \times 10^{-3}\ A$

$I_E = I_C + I_B = 2.02 \times 10^{-3}\ A$

25 **Answer (B)**

$I_C + I_B = 99\ mA$

$I_C\text{-}I_B = 97\ mA$

$I_C = 98\ mA\ ,\ I_B = 1\ mA$

$\beta_e = 98/1 = 98$

26 **Answer (B)**

When the current is zero, V_CE equals the battery voltage:

$V_{CC} = 5\ V$

The slope gives the resistance:

$R_C = (\Delta\ V)/(\Delta\ I) = (3\ V)/(3\ mA) = 1\ k\Omega$

27 **Answer (D)**

A digital signal is pulses: only zero or one.

28 **Answer (B)**

Sending: converter (1) changes analog to digital.

Receiving: converter (2) changes digital to analog.

29 **Answer (A)**

A physical quantity, then an analog signal, then a digital one for sending, then the reverse when receiving.

30 **Answer (B)**

Split the number into powers of 2:

$20 = 16 + 4 = 2^4 + 2^2$

$(10100)_2$

31 **Answer (D)**

$1 + 1 + 1 + 1 = 4 = 2^2$

$4 = (100)_2$

32 **Answer (C)**

Each digit is multiplied by its weight from the right: 1, then 2, then 4, then 8.

$(1010)_2 = 1\times 8 + 0\times 4 + 1\times 2 + 0\times 1 = 10$

33 **Answer (D)**

With three inputs there are 8 input cases.

An OR gate gives 0 in only one case, which is 000.

$7/8 = 87.5\%$

34 **Answer (B)**

An AND gate gives 1 in only one case, which is 111.

35 **Answer (C)**

The AND gate needs C = 1 and the output of the OR gate to be 1,

and the OR output is 1 if A = 1 or B = 1,

so the suitable row is C = 1, B = 0 and A = 1.

36 **Answer (A)**

The output is 1 in every row that has at least one 1,

which is an OR gate.

37 **Answer (B)**

The NOT gate inverts each digit:

11001 becomes 00110.

38 **Answer (A)**

When A = B = 0: the AND gate gives 0 and B = 0, so the output is 0.

When A = B = 1: the AND gate gives 1, so the output is 1.

39 **Answer (C)**

The AND branch gives 1 only if A = 1 and B = 1,

and the NOT branch gives 1 if C = 0.

When A = 1, B = 0 and C = 0, the NOT branch gives 1, so the output is 1.

40 **Answer (A)**

The output C equals A in all rows and does not depend on B.

If G were an AND gate, it would give 1 only when A = B = 1,

so A stays the one controlling the output, which matches the table.

41 **Answer (D)**

Gate X is on A alone, so it is NOT and gives 1 when A = 0,

and gate Y takes its result with B: an OR gate gives 1, so the output is 1.

42 **Answer (D)**

When A = B = 0, the OR branch made of NOT A and B gives 1,

and gate X gives 0 there; if Y were AND the output would be 0, so Y is OR.

When A = 1 and B = 0 the output must be 0, so X must be AND.

43 **Answer (C)**

First row: C = 1 and B = 1 and the output is 0, so x = 0.

Second row: C = 0, so the output y = 0.

Third row: the output is 1, so all inputs are 1, that is z = 1.

44 **Answer (A)**

The table gives 0 only when A = 1 and B = 0.

This is the output of NOT A followed by OR with B.

45 **Answer (C)**

The two switches are in parallel: the lamp lights if at least one of them is closed.

This is an OR gate, and the rows $(1, 0, 1)$ and $(0, 1, 1)$ satisfy it.

46 **Answer (C)**

Switch A is in parallel with the lamp: closing it makes a short circuit and turns the lamp off.

The lamp lights when B is closed, C is closed and A is open,

that is AND of NOT A, B and C.

47 **Answer (C)**

Read the output column from the last row to the first.

NOT A followed by OR with B gives 1, 1, 0, 1 from the top, so 1011 from the bottom.

$(1011)_2 = 8 + 2 + 1 = 11$

Essay questions

1 **Model answer**

Free electrons diffuse from the emitter (n-type) to the base (p-type), making the emitter current (I_E).

A small part of the free electrons is used up inside the base in recombination, making the base current (I_B).

Because the base is very thin, most of the free electrons move on to the collector, making the collector current (I_C).

2 **Model answer**

Because the base is very thin and lightly doped, so only a very small part of the emitter current is used up in it. So I_C *simeq* I_E, and the distribution constant $\alpha_e = I_C/I_E$ is close to one.

And since the base current is very small compared to the collector current, the amplification ratio $\beta_e = I_C/I_B$ is greater than one.

3 **Model answer**

Valency of the impurity atoms: emitter pentavalent, collector pentavalent.

Type of connection with the base: emitter forward, collector reverse.

Barrier voltage with the base: emitter small, collector large.

4 **Model answer**

The relation: $\alpha_e = I_C/I_E$

The slope: $slope = (\Delta I_C)/(\Delta I_E) = \alpha_e$

5 **Model answer**

(1) The npn transistor is connected in a common emitter circuit.

(2) The collector is connected to a positive voltage.

(3) The emitter and base are forward biased with a suitable voltage: the emitter connected to a negative voltage and the base to a positive one.

6 **Model answer**

The transistor is pnp, because the ohmmeter reads infinity when the diode junction is reverse biased, that is when the negative terminal of the ohmmeter is connected to the (p-type) and the positive terminal to the (n-type).

7 **Model answer**

(1) $\alpha_e \beta_e = (I_C^2)/(I_E I_B)$, $(I_C + I_B) I_B = (I_C^2)/(\alpha_e \beta_e)$

$(99 + I_B) I_B = ((99)^2)/98.01$, $I_B^2 + 99 I_B - 100 = 0$

$I_B = 1\ mA$

(2) $I_E = I_C + I_B = 99 + 1 = 100\ mA$

8 **Model answer**

$\alpha_e = I_C/I_E = I_C/(I_C + I_B)$, $I_C + I_B = I_C/(\alpha_e)$

$I_B = I_C/(\alpha_e) - I_C$

$I_B = I_C\ (1/(\alpha_e) - 1)$

9 **Model answer**

(1) $V_{CC} = V_{CE} + I_C R_C$, $5 = 0.3 + (I_C \times 5 \times 10^3)$

$I_C = 0.94 \times 10^{-3}\ A$

$\beta_e = I_C/I_B$, $30 = (0.94 \times 10^{-3})/I_B$, $I_B = 0.031 \times 10^{-3}\ A$

(2) $\alpha_e = (\beta_e)/(1 + \beta_e) = 30/(30 + 1) = 0.97$

10 **Model answer**

(1) Lamp P_1 gets dimmer and lamp P_2 gets brighter, because when the slider moves from x towards y the resistance connected to the base increases, so the base current decreases and the collector current decreases. The potential difference across P_1 decreases, so it gets dimmer, and the potential difference across P_2 increases, so it gets brighter.

(2) A straight line sloping down that cuts both axes, since: $V_1 + V_2 = V_{CC}$

11 **Model answer**

(1) Connect a battery between the base and the emitter (through a resistor R_B) with its positive terminal to the base, and connect a battery V_{CC} between the end of the lamp and the emitter with its positive terminal to the lamp (the collector).

(2) Reverse the connection of the battery connected to the base (V).

12 **Model answer**

Because when there is no light the base current stops, so I decreases and IR_C decreases, so the potential difference across lamp y increases and the lamp lights, since $IR_C + V_y = V_{CC}$ = constant. So the transistor works as an inverter.

13 **Model answer**

(1) Because of the interference caused by electric noise from the random motion of free electrons in the air, which mixes with the analog signal carrying the information and distorts it.

(2) Because in digital electronics the electronic noise from the random motion of electrons does not affect the digital information, since the information is in the code (1, 0), so it does not distort the sound or picture.

14 **Model answer**

Converting the electric signal into a code based on only two values, (0, 1).

15 **Model answer**

(1) By dividing by 2 again and again, the remainders from last to first: $(111011)_2$

(2) By dividing by 2 again and again: $(1111000)_2$

16 **Model answer**

(1) $(100110)_2 = 32 + 0 + 0 + 4 + 2 + 0 = 38$

(2) $(10011011)_2 = 128 + 0 + 0 + 16 + 8 + 0 + 2 + 1 = 155$

17 **Model answer**

$(11110)_2 = 16 + 8 + 4 + 2 + 0 = 30$

$(110)_2 = 4 + 2 + 0 = 6$

$30/6 = 5$

18 **Model answer**

(1) AND followed by NOT: A=0, B=0 output 1 / A=0, B=1 output 1 / A=1, B=0 output 1 / A=1, B=1 output 0

(2) OR followed by NOT: A=0, B=0 output 1 / A=0, B=1 output 0 / A=1, B=0 output 0 / A=1, B=1 output 0

19 **Model answer**

Output = NOT (C OR (A AND B))

(1, 1, 0) output 0 / (1, 0, 1) output 0 / (0, 0, 1) output 0

The output $(000)_2 = 0$

20 **Model answer**

Output = (A AND B) OR (NOT B)

(0, 0) output 1 / (0, 1) output 0 / (1, 0) output 1 / (1, 1) output 1

The output $(1011)_2 = 11$

21 **Model answer**

Output = (A AND B) OR ((NOT A) OR B)

(0, 0) output 1 / (0, 1) output 1 / (1, 0) output 0 / (1, 1) output 1

The output $(1101)_2 = 13$

22 **Model answer**

Output = (A AND B) AND (B OR C) AND (NOT C)

(0, 0, 0): 0 / (1, 1, 0): 1 / (1, 0, 1): 0 / (0, 1, 1): 0 / (0, 0, 1): 0 / (1, 1, 1): 0

The output $(010000)_2 = 16$

23 **Model answer**

Output = (A AND B) OR NOT (A OR B)

(0, 0) output 1 / (0, 1) output 0 / (1, 0) output 0 / (1, 1) output 1

The output $(1001)_2 = 9$

24 **Model answer**

Output = (A OR (NOT B)) AND ((NOT A) OR B)

(0, 0) output 1 / (0, 1) output 0 / (1, 0) output 0 / (1, 1) output 1

The output $(1001)_2 = 9$

25 **Model answer**

(1) A, B: (0, 0) 0 / (0, 1) 1 / (1, 0) 1 / (1, 1) 0

(2) The output is 1 only when A = B = C = 1, and 0 in all other cases

(3) The output is 1 only when A = B = C = 1, and 0 in all other cases

(4) A, B: (0, 0) 1 / (0, 1) 1 / (1, 0) 0 / (1, 1) 1

26 **Model answer**

(1) Gate X: OR, gate Y: AND, gate Z: NOT

(2) Second row: N = 1, C = 0

Third row: M = 1

27 **Model answer**

Gate X: AND, gate Y: AND, gate Z: OR

28 **Model answer**

(1) Gate X: AND, gate Y: OR

(2) The output Z = 0

29 **Model answer**

(1) (1, 1): 0 / (0, 1): 0 / (1, 0): 0 / (0, 0): 1

(2) An OR gate followed by a NOT gate

Past exam questions

1	2	3	4	5	6	7	8	9	10
C	A	B	C	A	B	B	A	A	D
11	12	13	14	15	16	17	18	19	20
A	B	C	C	B	B	—	C	B	D
21	22	23	24	25	26	27	28	29	30
B	A	C	C	C	B	C	D	C	B
31	32	33	34						
B	A	B	C						

1 **Answer (C)**

$I_B = V/R_B = 0.2/4000 = 5 \times 10^{-5}\ A$

$I_C = I_E - I_B = 10^{-3} - 5 \times 10^{-5} = 0.95 \times 10^{-3}\ A$

$R_C = (V_{CC} - V_{CE})/I_C = (1.5 - 0.8)/(0.95 \times 10^{-3}) = 7.37 \times 10^2\ \Omega$

2 **Answer (A)**

$I_C = V/R_C = 4.8/(4.5 \times 10^3) = 1.067 \times 10^{-3}\ A$

$\beta_e = I_C/I_B = (1.067 \times 10^{-3})/(33 \times 10^{-6}) = 32.32$

$\alpha_e = (\beta_e)/(1 + \beta_e) = 0.97$

3 **Answer (B)**

$\beta_e = (\alpha_e)/(1 - \alpha_e) = 0.97/0.03 = 32.33$

$I_C = \beta_e I_B = 32.33 \times 2 = 64.67\ mA$

4 **Answer (C)**

$I_C = \beta_e I_B = 200 \times 1 \times 10^{-3} = 0.2\ A$

5 **Answer (A)**

$I_C = (V_{CC} - V_{CE})/R_C = (5 - 0.5)/(50 \times 10^3) = 9 \times 10^{-5}\ A$

$I_B = I_C/(\beta_e) = (9 \times 10^{-5})/30 = 3 \times 10^{-6}\ A$

6 **Answer (B)**

$V_{R_C} = V_{CC} - V_{CE} = 1.5 - 0.2 = 1.3\ V$

7 **Answer (B)**

$I_C = (1.5 - 0.4)/400 = 2.75 \times 10^{-3}\ A$

$\beta_e = (2.75 \times 10^{-3})/(6 \times 10^{-5}) = 45.8$, $\alpha_e = (\beta_e)/(1 + \beta_e) = 0.979$

$(\alpha_e)/(\beta_e) = 2.1 \times 10^{-2}$

8 **Answer (A)**

$\beta_e = (\alpha_e)/(1 - \alpha_e) = 0.99/0.01 = 99$

$I_E/I_B = 1 + \beta_e = 100$

9 **Answer (A)**

$\beta_e = 0.95/(1 - 0.95) = 19$

$I_C = 19 \times 6 = 114\ \mu A$, $I_E = I_C + I_B = 120\ \mu A$

10 **Answer (D)**

$I_E = 120\ I_B$, $I_C = 119\ I_B$

$\alpha_e = I_C/I_E = 119/120 = 0.99$

11 **Answer (A)**

V_{CC} is the battery voltage, so it does not change when R_B changes.

12 **Answer (B)**

$\alpha_e = (\beta_e)/(1 + \beta_e) = 150/151 = 0.99$

13 **Answer (C)**

$I_C = \beta_e\ I_B = 99 \times 6 = 594\ \mu A$

$V_{CE} = V_{CC} - I_C\ R_C = 3 - 594 \times 10^{-6} \times 3 \times 10^3 = 1.218\ V$

14 **Answer (C)**

$I_E/I_B = 1 + \beta_e = 94.6$

15 **Answer (B)**

In an npn transistor the p base is between two n regions, so it is equivalent to two diodes whose positive (p) ends meet at the base.

16 **Answer (B)**

Common base connection: $I_C < I_E$, so it does not amplify the current $(\alpha_e < 1)$, but it amplifies the power because the collector circuit resistance is large.

17 **Model answer**

$2 \times 10^{-3}\ A$

18 **Answer (C)**

Output = (X AND Y) OR (X AND Y), so it is 1 when X = Y = 1.

19 **Answer (B)**

In circuit (B): AND(1, 0) = 0, then NOT gives 1.

20 **Answer (D)**

Output = (NOT X) AND (X OR Y)

It is 1 when X = 0, Y = 1.

21 **Answer (B)**

In (B): NOT(0) = 1, then AND(1, 1) = 1, so the output is high.

22 **Answer (A)**

N = (X AND Y) OR NOT (Y OR Z)

When X = 0, Y = 1, Z = 0: X AND Y = 0, NOT(1) = 0, so N = 0

23 **Answer (C)**

NAND gate: the lamp goes off only when both switches are closed together and short the lamp, so they are in series with each other and in parallel with the lamp.

24 **Answer (C)**

Switches Y and Z are in parallel (OR), and together they are in series with X (AND).

X AND (Y OR Z)

25 **Answer (C)**

Switches A and B are in series (AND).

Switches C and D short the lamp when closed, so it lights only when they are open (NOT).

A AND B AND (NOT C) AND (NOT D)

26 **Answer (B)**

Output = (NOT A) AND (B OR C)

It is 1 when A = 0 and B or C = 1, that is (0, 0, 1).

27 **Answer (C)**

With two switches in parallel the lamp lights when either of them is closed, which is the work of an OR gate.

28 **Answer (D)**

Z = (A AND B) OR (B AND C)

When A = 1, B = 0, C = 1: each of them is 0, so Z = 0

29 **Answer (C)**

The output is 0, so the output of G must be 0 for the input $(1, 1)$.

In (C): NOT(1) AND NOT(1) = 0

30 **Answer (B)**

Increasing R_B decreases the base current, so the collector current I_C decreases.

$V_{CE} = V_{CC} - I_C R_C$, so the output voltage increases.

31 **Answer (B)**

$$V_{CE} = V_{CC} - I_C R_C = 1.5 - 2 \times 10^{-3} \times 600 = 0.3\ V$$

32 **Answer (A)**

N = (X AND Y) OR NOT (Y OR Z)

When X = 0, Y = 1, Z = 0: X AND Y = 0, NOT(1) = 0, so N = 0

33 **Answer (B)**

D = (NOT A) AND (B AND C)

The lamp lights when B and C are both closed (in series) and A is open, since switch A shorts the lamp (in parallel with it).

34 **Answer (C)**

Output = ((NOT A) AND B) OR (A AND (NOT B))

It is high for $(0, 1)$ and $(1, 0)$, so the number of cases is 2